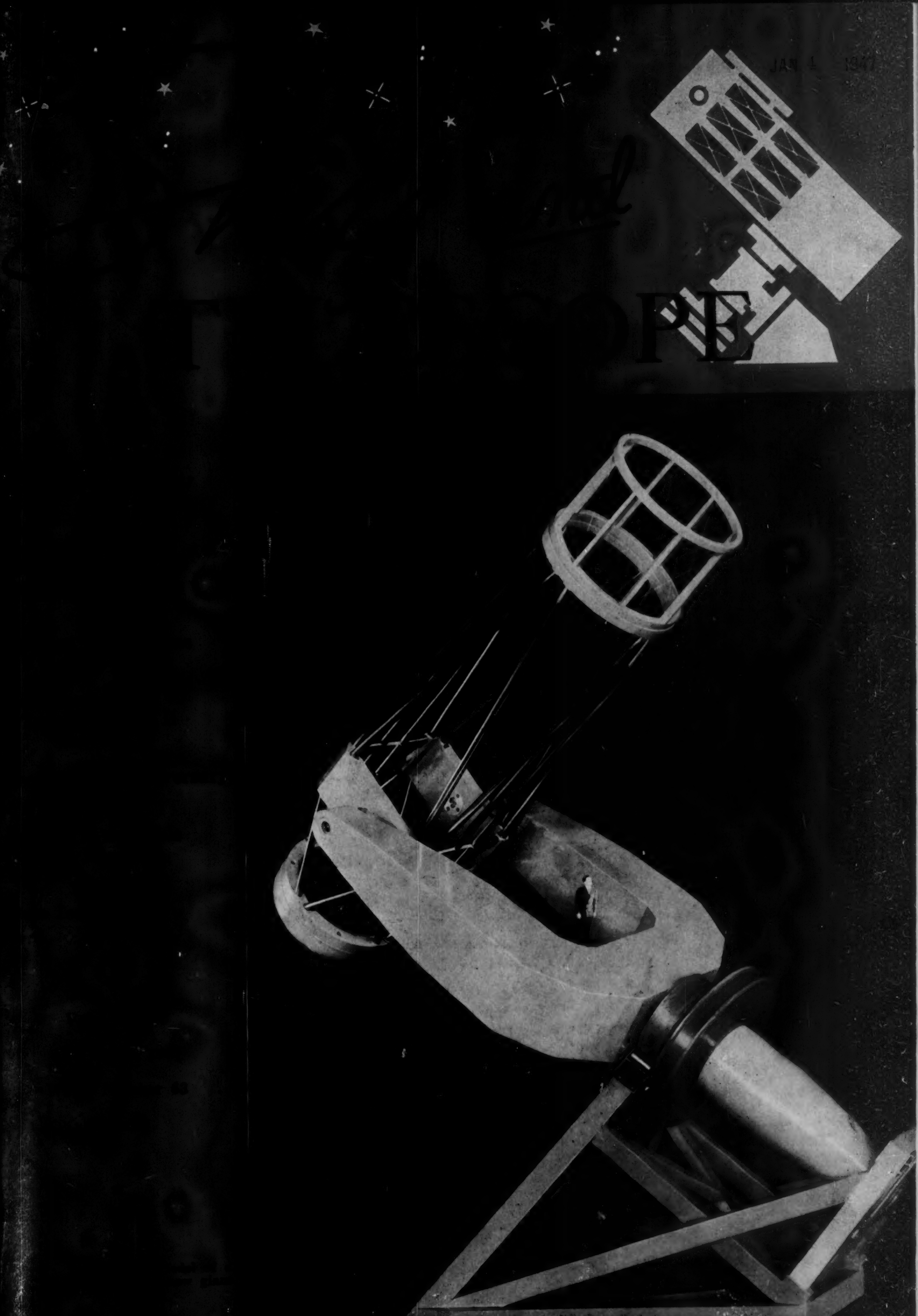

New Telescope at Lick

MOUNT HAMILTON in California will soon be the site of the world's second largest telescope, if all goes well with present plans to start construction of a giant 120-inch reflector at Lick Observatory next year. The design of the new instrument is now nearly complete, and further progress in the project waits only for favorable business and construction conditions. The cost of the complete instrument is estimated at $1,200,000, with four years or more required to build it.

The front-cover illustration shows a scale model, 1/16 actual size, the model built by W. W. Baustian, designer of the 120-inch reflector. The figure of a man has been scaled down to indicate the enormous size of the completed telescope, which will be housed in a dome 90 feet in diameter.

Those familiar with telescope designs will be quick to note the fork-type mounting, unusual for so large a reflector, but now taking its place as a form of mounting with many advantages when properly engineered. The 60-inch telescope at Mount Wilson and the 61-inch Wyeth reflector at Harvard's Oak Ridge station are similarly mounted, but they are only half the diameter of the new instrument. The fork mounting will permit observation of the entire sky to within five degrees of the horizon, including the polar regions, and without necessitating any swing over the pier when crossing the meridian. Counterweighting is reduced to a minimum for any position of the telescope.

The telescope mirror will be 16 inches thick and weigh eight tons. On the advice of Mount Palomar engineers it will be a solid glass disk, making for easier grinding and polishing and freedom from bending under its own weight — difficulties encountered with disks with hollowed backs, such as the 200-inch mirror. The tube will be 53 feet long, and the steel fork will weigh 70 tons.

Dr. C. D. Shane, director of Lick Observatory, states that the instrument has been designed along conservative lines in order to permit installation of any type of auxiliary equipment. It will be possible for observers to work at the prime focus, at the Newtonian, Cassegrainian, and Coude focuses.

Modern photographic instruments have long been exploited by Lick astronomers to the full in the operation of their 36-inch reflector and 36-inch refractor, largest Lick instruments at present. They expect with the 120-inch telescope to penetrate the universe of galaxies out as far as 900 million light-years, which is second only, of course, to the limit of the Mount Palomar instrument. It is expected that co-operative research programs will be undertaken by Lick and Palomar astronomers in order to avoid duplication of effort with the two giant reflectors. Lick will place emphasis on the motions and detailed structural features of the nearer galaxies, as a means of understanding the structure and evolution of the universe.

Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

The Editors Note . . .

FOR THE FIRST TIME since January, 1940, this magazine is appearing without Astronomical Anecdotes. For seven years this feature has ranked as a very popular department of **Sky and Telescope**, with an appeal universal among our readers, be they young or old, novice or professional.

Always interesting, sometimes controversial, Astronomical Anecdotes has brought to light many obscure points of astronomical history, has covered current happenings no older than yesterday's headlines, has discussed the foibles of famous astronomical personages, and has presented problems and questions of special interest to amateur astronomers. All this has been done in a manner and style peculiar to "R. K. M.," and with authority and precision bespeaking his wide reading and technical training.

Dr. Roy K. Marshall, the director of the Fels Planetarium in Philadelphia, has found it necessary to discontinue the writing of this column because of the press of a vast assortment of other duties, among them his part in the establishment of a new section of the Franklin Institute devoted to matter and energy.

The seven-year tenure of Astronomical Anecdotes is coincident with our own period of editorship and publication of The SKY and **Sky and Telescope**. Thanks from our readers and ourselves are extended to Dr. Marshall for his long and faithful service, with the hope that some day his column may resume its natural place in this periodical.

Also at this time it is appropriate to express thanks to the Maryland Academy of Sciences for its courtesy in supplying, for the sixth consecutive year, the Graphic Time Table of the Heavens. The plate, prepared at the Academy, is lent to us each January, and readers may obtain large reproductions at cost. This capsule fund of ephemeris material has become a familiar sight wherever there are people interested in current events in the sky.

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JANUARY, 1947

CONTENTS

COVER: A model of the proposed Lick Observatory 120-inch reflector, which on completion will take its place as the second largest telescope of the world. (See article on this page.)

BACK COVER: A portion of the moon near last quarter, from a Lick Observatory photograph taken with the 36-inch refractor by J. H. Moore and J. F. Chappell. This is Plate X in the series. (See In Focus.)

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The Optical Glass Industry

Past and Present

BY FRANCIS W. GLAZE, *Technologist, National Bureau of Standards*

THE EARLIEST LENSES known to have been employed were probably hand magnifiers, as both Seneca and Aristophanes mention them. Quartz and glass lenses have been unearthed from the ruins of Nineveh, Pompeii, and Herculaneum. Ptolemy, A.D. 100, wrote a whole book on optics.

A portrait, painted in 1352, shows two mounted lenses, with handles riveted together, in front of the eyes of the subject. The invention of printing by Gutenberg, in the middle of the 15th century, stimulated the use of such spectacles; but, even so, it was not until 1760 that Benjamin Franklin invented the first pair of bifocal spectacle lenses.

It seems likely that the increasing use of spectacles furnished the impetus, directly or indirectly, for the development of both the microscope and the telescope. Some authorities credit the invention of both instruments to Johann and Zacharius Jansen in 1590, while others give credit to Hans Lippershey or James Metius of Alkmaar for the creation of the telescope about 1608. In any case, between 1590 and 1620, interest in the telescope developed rapidly. This early work on the telescope was with the refractor type of instrument. It was not until 1670 that Sir Isaac Newton described to the Royal Society the first reflecting telescope and also demonstrated its use. However, a similar type of instrument had been described by James Gregory in his *Optica promota* in 1663. Another type of reflecting telescope was invented in 1672 by Cassegrain.

During the next 200 years, many improvements were made in optical instruments, thereby giving great impetus to the search for better optical glass. Its quality was greatly improved by the discovery, in 1790, of a method of producing a glass chemically homogeneous and substantially free from imperfections such as "stones" and bubbles. This invention and much of its subsequent development must be credited to Pierre-Louis Guinand, a Swiss watchmaker, and his descendants and their associates. They found that chemical homogeneity could be obtained by stirring the molten glass and also discovered means of annealing the resultant product. Later Guinand worked with J. Fraunhofer in Bavaria. The latter ultimately attained considerable success and produced telescope disks up to 28 centimeters (11 inches) in diameter. He further initiated the specification of refraction and dispersion in terms of certain lines of the spectrum, and he even attempted an investigation of the effect of chemical composition on the relative dispersion produced by glasses in different parts of the spectrum.

One of the associates of the Guinand family, Bonteps, was forced to flee to England in 1848 because of political troubles. There he became connected with Chance Brothers, still one of the better known manufacturers of optical glass. E. and C. Feil, great-grandsons of Guinand, worked with E. Mantois; this association later developed into the famous French optical glass company of Parra-Mantois. In 1887, a son of C. Feil, Edmond Feil, went to England where he offered his knowledge to Chance Brothers.

Although much work was done by Faraday and Harcourt in England more than 100 years ago, the outstanding study of the relationship between composition and optical constants was carried out by O. Schott in an effort to develop glasses having the optical properties desired by Professor Abbe of the University of Jena, who was trying principally to develop better microscope objectives. Except for a limited number of coloring agents, the compounds of only five or six elements were in general use prior to 1880. Only two types of optical glass were known: crown, a lime glass, and flint, a lead glass. There were many shortcomings in lenses which simple combinations of these two types of glass could not overcome. Through the work of Schott and his collaborators at Jena, about 25 new elements or their compounds became available to the glass industry. Also, from this work developed the famous optical glass plant of Schott und Genossen. Schott discovered that the glasses compounded with these new materials possessed a wide range of optical properties, and this discovery made it possible to build up optical systems free from the defects previously exhibited.

As nearly as can be determined, the first successful manufacture of optical glass in the United States was by Macbeth and Company of Pittsburgh, Pa., about the year 1893 (possibly earlier). It is in this connection that we next hear of Edmond Feil, as superintendent of the firm's optical glass factory. This plant, according to Chance, finally managed to make "some beautiful glass of great purity and reasonably fine quality of annealing."

Evidently Feil did not remain with Macbeth and Company long, for in 1897 he was working with the Manhattan Optical Company and operating

An optical glass pot, and its stirring thimble, set in a pot arch preparatory to burning. Photographs are from the National Bureau of Standards.

Two melting furnaces at the National Bureau of Standards. The pot of glass in Furnace 5 is being stirred and its temperature is being determined by the furnace man by means of an optical pyrometer. The pot in Furnace 6 is being filled with batch.

a small glass plant at Cresskill, N. J. Their specialty was lenses for photographic purposes. Production started about 1896 and continued for approximately six years, after which the Manhattan Optical Company combined with the Gundlach Manufacturing Company of Fairport, N. Y., and the glass plant ceased operation. Thus it seems that the manufacture of optical glass in this country was undertaken with the assistance of a direct descendant (the great-great-grandson) of Pierre-Louis Guinand, one of the earliest workers in the field.

The National Bureau of Standards entered the field, in a preliminary way, at its Pittsburgh laboratory in July, 1914, under the direction of P. H. Bates, who retired from the Bureau shortly after V-J Day. Just prior to this (about 1912), the Bausch and Lomb Optical Company started work in the same field. Both of these organizations have been producing glass ever since.

It is evident from the foregoing that the manufacture of optical glass in the United States is a modern industry. Also, it is only an industry of moderate size except in wartime, as can be seen from the table on this page.

There are no accurate figures for the production of optical glass for the years 1919-1937, inclusive. However, it is safe to say that it did not appreciably exceed 61,000 pounds (1938 production) for any year in that time.

Optical glass, as used in lenses, functions as a medium to refract the rays of light from any distant object so that they will converge to a single corresponding point in the image. This requirement is extremely difficult to meet and demands that the glass in each lens (or prism) element be of uniform quality throughout and that its optical constants agree very closely with those of certain standard types of glass. To manufacture on a large scale a series of different types of glass of this degree of perfection requires close attention to details.

The characteristics of good optical glass are:

1. Homogeneity.
    a. Uniformity of chemical composition, including freedom from streaks of different compositions within the glass mass (striae).
    b. Freedom from seeds, or bubbles.
    c. Freedom from included fragments of undissolved material or crystallites within the glass mass (stones).
    d. Freedom from cloudiness.
2. Definite refractive indices for different wave lengths of light.
3. Freedom from color.
4. High degree of transparency.
5. High degree of chemical and physical stability.
    a. Resistance to action of weather and certain chemical agents.
    b. Toughness and hardness.

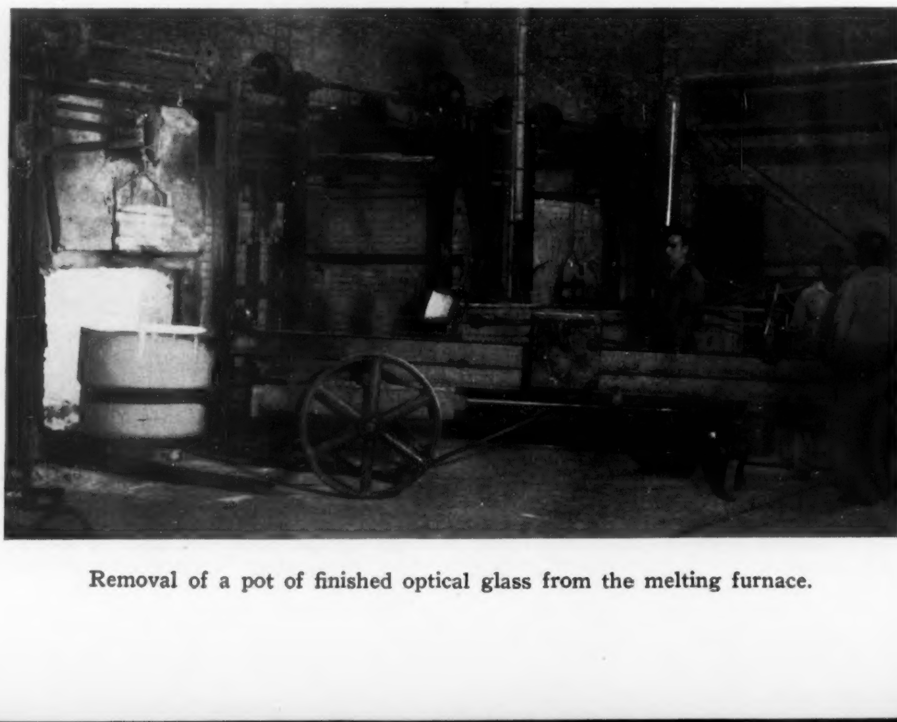
The art of making optical glass of the above characteristics is the subject of the following necessarily general account.

Practically all optical glass in the United States is made in pots which are used only once. Hence, the first requisite is a pot of the necessary refractoriness. And here we run into one of the main compromises necessary in connection with optical glass production. The denser or less porous a pot body is, the less it is attacked by the glass or its batch. But, the denser the pot body is, the more sensitive it is to thermal shock (sudden temperature change). So the type of body finally selected is somewhat less than the ideal both as to corrosion resistance and resistance to thermal shock.

Production of optical glass in the United States, in pounds:

World War I		World War II	
1917:		1938	61,000
April	2,850	1939	145,000
July	4,800	1940	260,000
October	15,645	1941	801,000
1918:		1942	2,851,000
January	35,955	1943	3,688,000
April	24,363		
July	55,355		
October	79,275		

The pots are made up essentially of four constituents: feldspar, ball or bonding clay, kaolin, and grog (old pot body). The porosity of the pot body is controlled by the particle sizes of the grog used. In this country, all pots are cast in a mold made of plaster of Paris. For the more corrosive glasses, pots are made more resistant by means of a dense lining. This provides the resistance to shock of a porous body and the resistance to corrosion of a dense body. After the pot has dried sufficiently so that it can be handled, it is removed from the mold and air-dried for three weeks or more. It is then ready to set in the pot arch for burning. This burning takes anywhere from 48 to 60 hours, depending on the density of the pot body, for pots of approximately seven cubic feet



Removal of a pot of finished optical glass from the melting furnace.

Cutting optical glass by means of the 24-inch diamond saw.

capacity such as are used at the National Bureau of Standards. Of course, the denser the pot body, the more slowly it should be burned. The pot can be fired completely in the pot arch or it can be partially fired in the pot arch and the firing completed in the melting furnace.

The transfer of the pot from the pot arch to the melting furnace is accomplished by means of a pot carriage. This is equipped with a pair of massive tongs operated from the rear of the carriage, and with a counterweight which can be moved along the carriage to balance the weight of the pot of glass. The melting furnace is generally regenerative, that is, built over two chambers of checkerwork which are alternately heated by the gases of combustion and then used to heat the incoming air necessary for combustion. The fuel usually is gas, preferably natural gas.

After the pot has been completely fired at the melting temperature of the particular glass it is designed to hold, it is ready to receive the batch and cullet (waste glass from previous melts). The time necessary to fill a pot with batch varies from five to 10 hours. The temperature of the melting furnace during this operation may be as low as 1,350° C. or as high as 1,450° C., depending on the difficulty with which the batch melts. After the batch has melted down and foaming has ceased, the stirring of the molten glass can be started. This is accomplished by means of a thimble made of the same materials as the pot, actuated by means of a water-cooled rod driven by a horizontal rotating drum and working over a pulley or a guide as a fulcrum.

As soon as the molten glass is reasonably free of seeds or bubbles of gas, it is gradually cooled to the temperature at which the pot of glass should be removed from the furnace. As the molten glass cools down, the rate of stirring must be decreased so that air will not be sucked into the glass in the wake of the stirring rod. Here is another example of compromise. If the rate of stirring is too fast, a seedy but homogeneous or striae-free glass is generally obtained; if it is too slow, a seed-free but striated glass results. The pot of glass is allowed to cool in the melting furnace until the viscosity increases to such an extent that any further stirring might ruin the glass. This temperature is the most critical and may vary from 950° to 1,100° C., depending on the type of glass. The time required to produce a pot of glass at the National Bureau of Standards varies from 19 to 28 hours.

After the pot of finished glass is removed from the melting furnace, the bottom of the pot is cooled by means of a blower until the glass is stiff enough so that there will be no movement of the contents due to convection currents. The pot is then covered with a thermally insulated can so that the glass will cool slowly enough to crack into fairly large chunks. The pot is then broken open, the pot body processed for grog, and the chunks of glass saved for further processing. Any imperfections present are trimmed from the chunks of glass by means of steel hammers or diamond saws. The chunks are then broken or sawed to a convenient size for molding into the blanks on order.

These pieces of glass are now put into a preheating furnace where they are gradually heated up to a temperature just below the softening point of the glass. They are picked up by the molder on the end of a steel rod (punty rod) and then heated well above their softening point in a molding furnace and worked into the proper shape for molding. When properly shaped and at the proper temperature, each gob of glass is held over the steel mold and the proper amount of glass is cut off by a pair of shears and pressed into shape. Upon removal from the mold, each blank is placed in a cooling lehr and cooled slowly to prevent cracking.

The above molding procedure is the best for medium-size and large blanks. In the case of small blanks it is best to mold slabs of proper thickness, break each slab into cubes weighing a little more than the desired blank and then adjust to correct weight on a grinding wheel, especially rounding off all corners and sharp edges. The pieces of glass are fed into a small paddling furnace, gradually brought up to molding temperature, worked into approximate shape by means of paddles, and pulled into the steel mold and pressed. To keep them from cracking, the blanks are then placed in an oven attached to the paddling furnace.

In the case of blanks too large to work by hand, the glass pieces are placed in a ceramic mold and gradually brought up to a sufficiently high temperature so that they will soften and flow into the shape of the mold. They are then slowly cooled so they will not crack.

In any case, the blanks are then inspected. They are immersed in a liquid of index of refraction similar to that of the glass. In such a liquid, the glass surfaces disappear and the imperfections in the interior become evident under proper illumination. The blanks are also gauged for conformity with specifications, those undersize being marked for salvage into smaller blanks and those oversize for grinding to size. The rest are ready for annealing.

The annealing of optical glass is a critical process. Blanks of widely different weights require different annealing schedules even though they are both made of the same glass. Also, each type of glass has its own annealing schedule except where two glasses are similar in composition. The blanks are loaded into an iron box on perforated iron trays with an air space between the layers. The use of the box and trays gives much better temperature distribution throughout the annealing furnace. The furnace is gradually raised to the annealing temperature and held at that temperature until, from experience, it is known that the glass in the furnace is free of strain. Now it becomes necessary to cool the furnace at such a rate that no strain will be introduced because of temperature gradients within the glass. The cooling rate is very slow at first and is gradually increased as the temperature drops. If properly annealed, an optical element should show no distortion throughout its life.

The final process before shipment or grinding and polishing is the inspection for strain. The blanks are again immersed in a liquid of index of refraction similar to the glass and examined with polarized light. If the glass is perfectly annealed, the area of the glass appears the same as the adjoining background. Otherwise, an interference figure is obtained. This interference figure is compared with that for standard strain samples to determine if the annealing is satisfactory for optical purposes. If not, the blank must be reannealed.

And so, after about one month, the batch that was put into the pot appears as a satisfactory finished blank, ready for grinding and polishing into an optical element. In other words, there is present in a plant producing optical glass a month's production of glass. Also, only about 15 to 18 per cent of the glass melted is satisfactory for grinding and polishing; hence, the high cost of good quality optical glass.

(To be concluded.)

NEWS NOTES

BY DORRIT HOFFLEIT

OCEAN BLUE

Professor F. A. Jenkins, University of California physicist, and Dr. I. S. Bowen, now director of Mount Wilson Observatory, in 1941 made investigations of military value on the penetration of light in ocean waters. They conducted this research at the U. S. Navy Electronics Laboratory in San Diego, using some of the facilities of the Scripps Institution of Oceanography at the University of California.

The ocean does not look blue because of the scattering of light by molecules (the reason for a blue sky) as had been previously assumed; nor because of reflected blue sky light. In seeking means for the detection of enemy submarines, the investigators found that light rays could not be used to advantage because they had a maximum penetration in water of only 580 feet. This limitation is due to the fact that every cubic inch of clear ocean water contains about one and one-half million tiny dust particles, each on the order of 1/50,000 of an inch in diameter.

These particles reflect incident light rays. The reflected light has been filtered: water absorbs red and yellow light so that the emerging reflected colors, green, blue, and violet, give the ocean its common indigo appearance. Wherever non-indigo ocean colors are found, they can nearly always be attributed to microscopic marine plant and animal life.

OBSERVATIONS OF ROCKET METEORS

As this issue goes to press, Dr. Fred L. Whipple, of Harvard Observatory, is on his way to White Sands Proving Ground, New Mexico, to operate meteor observing cameras at the time of firing the V-2 rocket scheduled for December 17th. When the rocket reaches a height of 20 miles, it will begin to throw out "meteorites" in swarms and will continue to do so to a height of about 40 miles. These missiles, of iron, will leave the rocket head at the same speeds at which natural meteors enter the earth's atmosphere.

During recent months, Dr. Whipple had in experimental operation the cameras he will use to make observations of the meteors. They are giant aerial cameras equipped with rotating shutters to chop the meteor trails so that velocities may be obtained. Each camera will cover an area of about 40 degrees and they will be set up sufficiently far apart to furnish a baseline for height determinations. Only one exposure will be taken with each camera, representing less than 30 seconds of the rocket's flight.

Success with this experiment may enable astronomers to compare actual sizes of meteors with sizes computed from observed meteors and assumptions concerning the upper atmosphere and energy generation when a meteor burns. Of considerable importance will be information concerning the density of the upper air, revealed in part by the rate at which resistance by the atmosphere decelerates a meteor.

The experiment is being conducted under the joint auspices of the U. S. Army Ordnance Department, Johns Hopkins University, California Institute of Technology, and Harvard. An explosive device to be used for producing man-made meteorites was suggested by Dr. Fritz Zwicky, of Mount Palomar, who will also operate observing cameras, and designed by Dr. J. A. Van Allen, of Johns Hopkins Applied Physics Laboratory.

Besides the Harvard instruments, numerous motion-picture and still cameras will be employed from stations within 200 miles of White Sands. The observatories at Tucson and Flagstaff and others are also planning to photograph these "meteors."

SOLAR SPECTRUM IN FAR ULTRAVIOLET SECURED

An event of far-reaching astrophysical consequences occurred at White Sands Proving Ground on October 10th, when the ultraviolet spectrum of the sun at wave lengths shorter than 3400 angstroms was obtained from a V-2 rocket at a height of 88 kilometers. The limit of the spectrograph was 1100 angstroms. It is this region of the sun's spectrum which is normally absorbed by the ozone in the upper atmosphere. The new spectra clearly show the elimination of this absorption and the appearance of the spectrum in the ultraviolet as the rocket ascended above the ozone layer.

HARVARD OBSERVATORY CENTENNIAL

A century ago there arrived in thi country one of the two largest astronomical telescope lenses in the world. Harvard received its long-awaited 15-inch lens, equal of the famed objective at Poulkovo Observatory in Russia. In June, 1847, installation of the lens was complete and observations began. One immediate result was the discovery of Saturn's inner or crepe ring, by William Cranch Bond, first director of Harvard College Observatory.

The elaborate and combined meetings of the American Astronomical Society and Section D of the American Association for the Advancement of Science at Harvard during Christmas week marked the observance of the 100th anniversary at Harvard. It has recently been announced that Dr. Harlow Shapley, the observatory's fifth director, will be assisted by newly appointed Associate Director Bart J. Bok and Associate Director for Solar Research Donald H. Menzel. In addition, an observatory council has been formed of seven staff members to plan and carry out the scientific program of the observatory.

MAN-MADE SNOW

"Everybody talks about the weather but nobody does anything about it," attributed to Mark Twain, is no longer strictly so. Vincent J. Schaefer, of General Electric Research Laboratory, has been working on the production of ice crystals in a cloud of supercooled water droplets. Such droplets are in liquid form even though at a temperature well below freezing. In the laboratory he found that snow production was a very simple matter, and the knowledge that many clouds in the air are in a supercooled condition suggested that such clouds might be dissipated as snowfalls.

In an airplane flying over Greylock Mountain in Massachusetts, Schaefer dropped particles of dry ice (solid carbon dioxide) on a natural cloud and precipitated a snowstorm. One pellet of the dry ice might produce several tons of snow. This discovery will be valuable in aviation for preventing the icing of aircraft, and has a number of other applications.

RADAR AND RADIO IN ASTRONOMY

Still in its astronomic infancy, radio is well on its way to becoming a prober for scientific data of interest to astronomers. Radio noise correlated with solar activity is well known. Noise of cosmic origin promises to become a fact-finder on Milky Way structure. Theoretical astrophysicists are busy investigating the complexities of the radio spectrum, and speculating as to where within a star the radio waves may originate in order to escape through the stellar atmosphere so that we may observe them. Recently, Professor M. N. Saha, of India, suggested that radio noises received from the sun originate not in the chromosphere or reversing layer but only in the corona.

Radar equipment for meteor work has proved its worth. Clouds hindered both English and New England observers from seeing the Giacobinids (except from airplanes), but in both regions radar pips amply demonstrated the richness of the shower. English radar observers stated that the echoes at the peak between 3:30 and 4:30 GCT were too numerous to be counted visually on their cathode ray scopes, and must await detailed analysis of the photographic recordings.

WINTER CONSTELLATIONS

BY CATHARINE E. BARRY, *Hayden Planetarium*

Behold Orion rise,
His arms extended measures half the skies.

— MANILIUS

WITH THE ADVENT of the New Year, you might include in your list the resolution: "I shall look *up* for at least one half hour on every clear night throughout 1947." You would be assured, in keeping this resolution, of a truly happy new year with the stars.

If one is not going to make friends with those scintillating points of light, he might just as well have been born on Venus where he would never know of the beauty of the night sky. The clouds surrounding that planet are so dense that an observer there could not penetrate them to view the sun or the stars. Fortunate, indeed, we are to live on a planet which has a comparatively transparent atmosphere which permits us to have a truly intimate regard for the universe to which we belong. And without at least an introduction to the starry sky above, a comprehensible study of the real and apparent motions of heavenly bodies and a wise evaluation of other celestial phenomena is not possible.

Orion, the Giant or Great Hunter of the sky, is the unmistakable sign of winter. It is the most conspicuous constellation and contains more bright stars than do most other groups. The familiar configuration is that of a crude rectangle, diagonally crossed in the center by three bright stars which form Orion's belt. The belt is often referred to as the "yardstick," for it measures almost exactly three degrees in length. By referring to it you can learn to judge angular distances on the sky. The Arabians named these stars the belt, the line, the golden grains, and later, the accurate scale-beam. The same idea of a weighing-beam was known to the Chinese, according to R. H. Allen, in his *Star Names and Their Meanings*. There are people today who call Orion's belt the three mowers, the three kings, the golden yardarm, and the yardstick, as we have already noted.

This large constellation lies partly within the Milky Way, and the westernmost star of the belt, Mintaka, is near the celestial equator, so at least part of Orion can be seen from any place on the globe. The two stars forming the shoulders of the Giant (north of the belt) are Betelgeuse and Bellatrix; south of the belt, Saiph and Rigel mark respectively his right knee and his left foot.

Betelgeuse, a name which degenerated from *Ibt al Jauzah,* the armpit of the central one, is a variable star, a rich topaz in color, and a supergiant star whose diameter ranges between 300 and 480 times the sun's diameter. This star is at a distance of about 300 light-years, and it is several thousand times as bright as the sun.

Rigel, which is Beta in the constellation even though brighter than Betelgeuse, is intrinsically a very bright star. It is about twice as far away as Betelgeuse, and 21,000 times as bright as the sun.

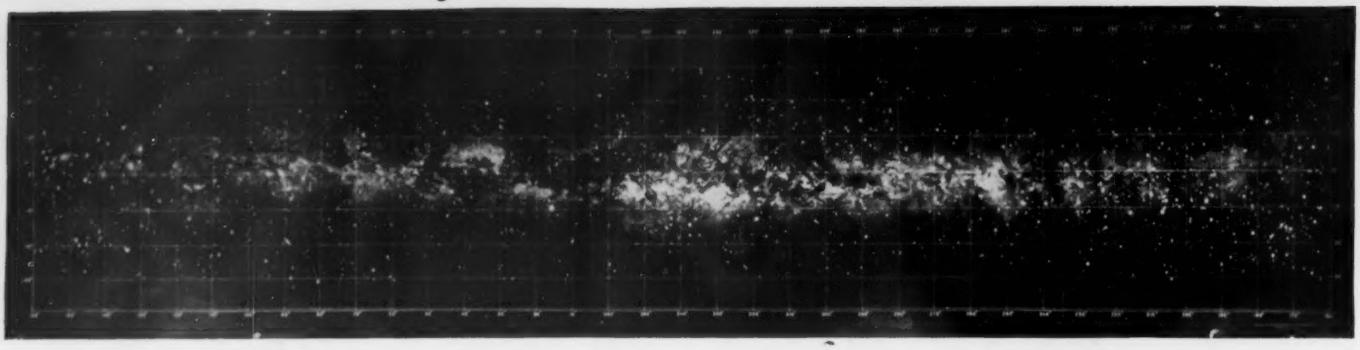
With the aid of good binoculars or field glasses, one of the most spectacular and glorious sights in our sky, the Great Nebula in Orion, can be studied. It is just visible to the naked eye as a hazy "star" in the line of three which form Orion's sword. A small telescope shows the four bright stars embedded in the nebulosity and forming the well-known and interesting Trapezium.

If you follow the belt of Orion westward and northward, you will sight the red star Aldebaran, the fiery eye of Taurus, the Bull. It is the bright star in the Hyades, a V-shaped cluster of stars. *Al debaran* means the follower, and refers to its trailing another famous cluster, the Pleiades, across the sky each winter night. The ancients referred to the Pleiades as the Seven Sisters, but because there is difficulty in locating the seventh star with unaided vision, our American Indians called these stars the Six Brothers. Together, the Pleiades and the Hyades make Taurus an important constellation for both amateur and professional astronomers.

The Taurids, a meteor shower which occurs in November, has been associated with Encke's comet by Dr. Fred L. Whipple, of Harvard. His work was based on numerous Harvard photographs of Taurid meteors, and showed the meteors to be traveling in orbits having periods of 3.3 years, practically the same as the period of Encke's famous comet.

The 2nd-magnitude star which forms one of the tips of the horns of the Bull is Nath, or Beta Tauri. Its name

A Harvard photograph of part of the winter sky, with Taurus in the center and Orion in the lower left.

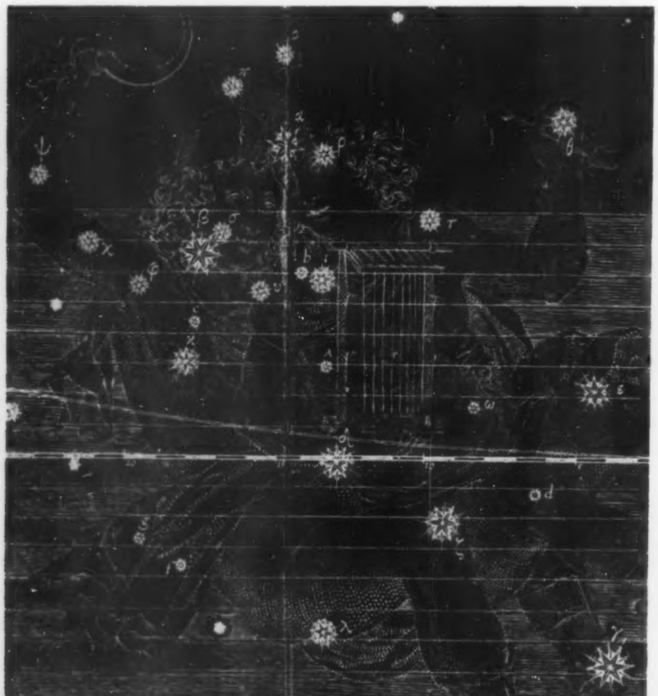


The full length of the Milky Way, drawn by O. Jahnke according to photographs by S. I. Bailey, at Harvard.

means "that which butts," and at one time it was also considered to be part of Auriga, which explains why that constellation has no star now known as Gamma Aurigae. Auriga, the Charioteer, forms a bright pentagon in the sky (including Nath), with Capella its brightest star. At the apex of the triangle of stars to the south of Capella is Epsilon Aurigae, an eclipsing double star which has an invisible companion some 3,000 times greater in diameter than our sun. The surface temperature of this "ghost star" is so low that its light is emitted principally in the infrared region of the spectrum. Once every 27 years it causes an eclipse and temporary fading in light of its visible primary. Eclipses of Epsilon Aurigae are important events for astronomers seeking to learn more of the nature of this almost unbelievably large and invisible star.

Returning to Orion's belt, if you follow its line of stars eastward and southward you will come to Sirius, the Dog Star, brightest star in the sky. It is one of our nearest stellar neighbors, a mere 8.8 light-years away. More than a hundred years ago it was suspected by Bessel of being double, but its 8th-magnitude companion was not seen in a telescope until 1862. The density of this companion star is so great that if some of the material of which it is made were brought to the surface of the earth it would weight 1,500 tons to the cubic foot! A lump the size of a tennis ball would weigh seven tons.

Sirius is in the constellation of Canis Major, the Larger Dog. Canis Minor, the Smaller Dog, with its brightest star Procyon, just north of Sirius, is the second of the two hunting dogs that follow Orion across the sky.



Gemini, the Twins, as the constellation is depicted in Bayer's atlas, published in the year 1603.

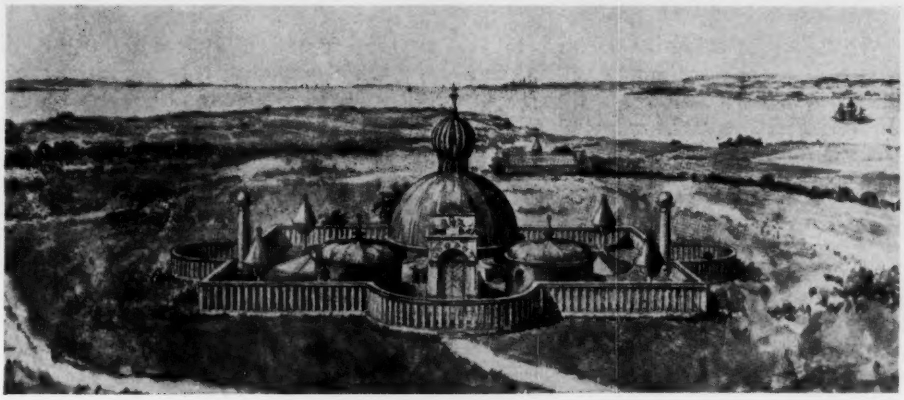
From Sirius it is easy to let the eyes tred that gauze-like path, the Milky Way, running northwest through Gemini, the Heavenly Twins (Castor and Pollux), Auriga, and on to Perseus and Cassiopeia. The last of these groups is marked by the familiar W, representing the Lady in the Chair. Perseus is not too conspicuous a configuration, but is located between the Pleiades and Cassiopeia.

Perseus was the hero who, according to legend, slew the Medusa and carried her head back dangling from his belt. The star representing the eye of the Medusa was called by the Arabs *Ra's al Ghul,* the Demon's Head. This star is the earliest known eclipsing double star, and probably the name refers to the star's periodically changing brightness. Ordinarily, Algol is of magnitude 2.3, but it drops to 3.5 every two days, 20 hours, and 49 minutes.

Gemini is represented by two parallel rows of stars, and the bright stars Castor and Pollux. Two of the principal planets were discovered in Gemini, Uranus in 1781 and Pluto in 1930. With small optical aid, double stars, triple stars, clusters, and the like can be found in this region.

East of Gemini is Cancer, the Crab, conspicuous by its lack of bright stars. However, it is easily located on moonless nights by a hazy spot called Praesepe, the Manger. This beautiful cluster of stars is more popularly known as the Beehive.

Only a few of the many constellations visible in the evening at this time of the year have been mentioned. Others which go to complete the sky picture can be located after their positions have been ascertained from a sky map. Once the configurations are fixed in your mind's eye, you will recognize them wherever or whenever you see them. Make a date with them for 1948; they'll be there at the same time and in the same places on the same date. It's fun to welcome old friends season after season. Don't forget your 1947 resolution—*look up!*



A reconstruction of Stjerneborg, by Charles Christensen.

THE ASTRONOMY OF TYCHO BRAHE

By C. M. Huffer

Washburn Observatory, University of Wisconsin

PART II

A GREAT CHANGE in the affairs of the Brahe family occurred in 1576. Tycho had spent about a year in residence in various parts of Europe. Near the end of 1575 he returned home, apparently with the intention of leaving Denmark and settling permanently in Switzerland. But because of the influence of certain friends with King Frederick, the king offered Tycho his choice of several castles for a residence. But Tycho refused, until finally the island of Hveen, off the coast of Denmark, was offered along with the promise of funds sufficient to build a house and an observatory there. After consultation with his friends, Tycho accepted the offer and was granted "five hundred good old daler" annually. To this grant the king later added others, including the revenue from an estate in Norway.

Hveen is about 2,000 acres in extent. It is irregular in shape, roughly triangular, the longest dimension being about three miles. The site of the new residence-observatory, called Uraniborg, was near the center of the island and about 160 feet above sea level. Construction was started early in August, 1576, and Tycho began observations in December, although the house probably was not finished until 1580.

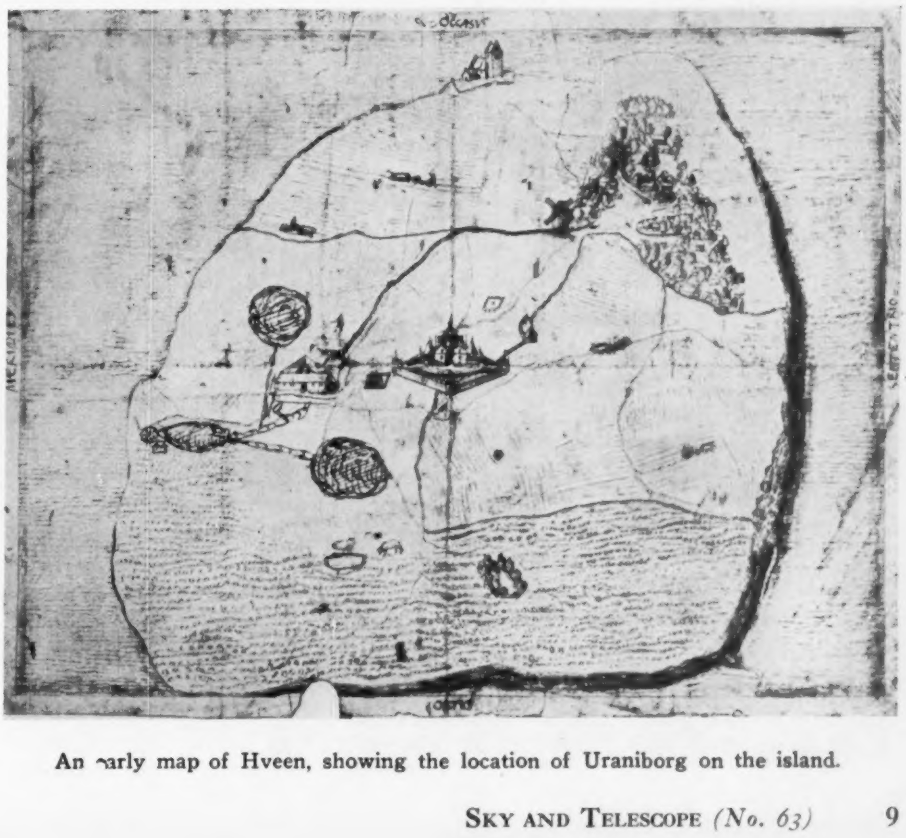
Uraniborg was placed inside a square enclosure 248 feet on a side, with the corners oriented to the four points of the compass. The walls of this enclosure were of massive masonry 18 feet high. Inside were orchards and gardens, with small buildings for the servants (including a prison). The building which was the observatory and residence of the astronomer's family was located at the center.

This main building gave the impression of a medieval castle with an astronomical touch. The style was Gothic Renaissance, with spires and gables in good taste; while inside, the decorations —pictures, inscriptions, and ornaments —had astronomical or scientific themes. Apparently observational astronomy was predominant, with living quarters secondary in importance. The observing rooms had conical roofs made of triangular boards which could be removed to permit a view of the whole sky. And the entire building was capped with an octagonal pavilion in the nature of an observing gallery where the astronomer could make time observations, and also note the direction of the wind and the state of the sky. This pavilion had a weather vane on top — the winged horse, Pegasus—which was 62 feet above the ground.

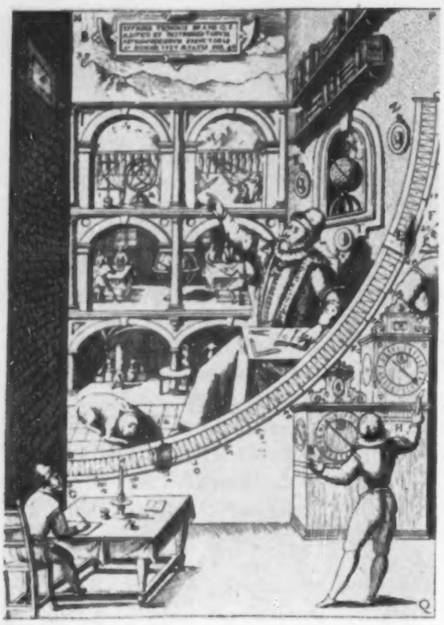
The first floor of the house proper was used for a family sitting room and for guest rooms, except one room, with a mural quadrant on the west wall, which was probably used as a study. The family bedrooms were on the second floor, and on the third floor were eight small rooms for students and observers. The south tower had a chemical laboratory in the basement, a library containing the great star globe on the main floor, and above that a large observing room with an armillary sphere. The north observing room, which also contained an armillary sphere, was above the kitchen in the tower on the north side of the building.

To supplement the observing rooms in Uraniborg, and in order that simultaneous, independent observations could be made, Tycho in 1584 built another building to serve as an observatory. This observatory, named Stjerneborg, was about 100 feet outside the enclosure of Uraniborg. It consisted of five observing rooms and a study-room and was built with only the roofs above ground.

In these two observatories, Tycho



An early map of Hveen, showing the location of Uraniborg on the island.



The large mural quadrant in Uraniborg, from an old engraving.

had several types of instruments. There were, of course, the mural quadrants and the more flexible sextants. The armillary spheres consisted of fixed, graduated circles oriented to the equator and to the meridian. A graduated, movable declination circle was equipped with sights for determining declination directly. The right ascension might be found provided accurate time could be kept. But clocks of the period were not perfect and the right ascensions seem to have been determined from standard stars. Of course, all the stars were also observed with the mural quadrants which were fixed in the meridian. Some of the armillary spheres were almost certainly oriented to the ecliptic for determining celestial latitude and longitude. The instruments were, of course, without optical aid, since they all preceded the invention of the telescope. They were nearly all made in Tycho's shops.

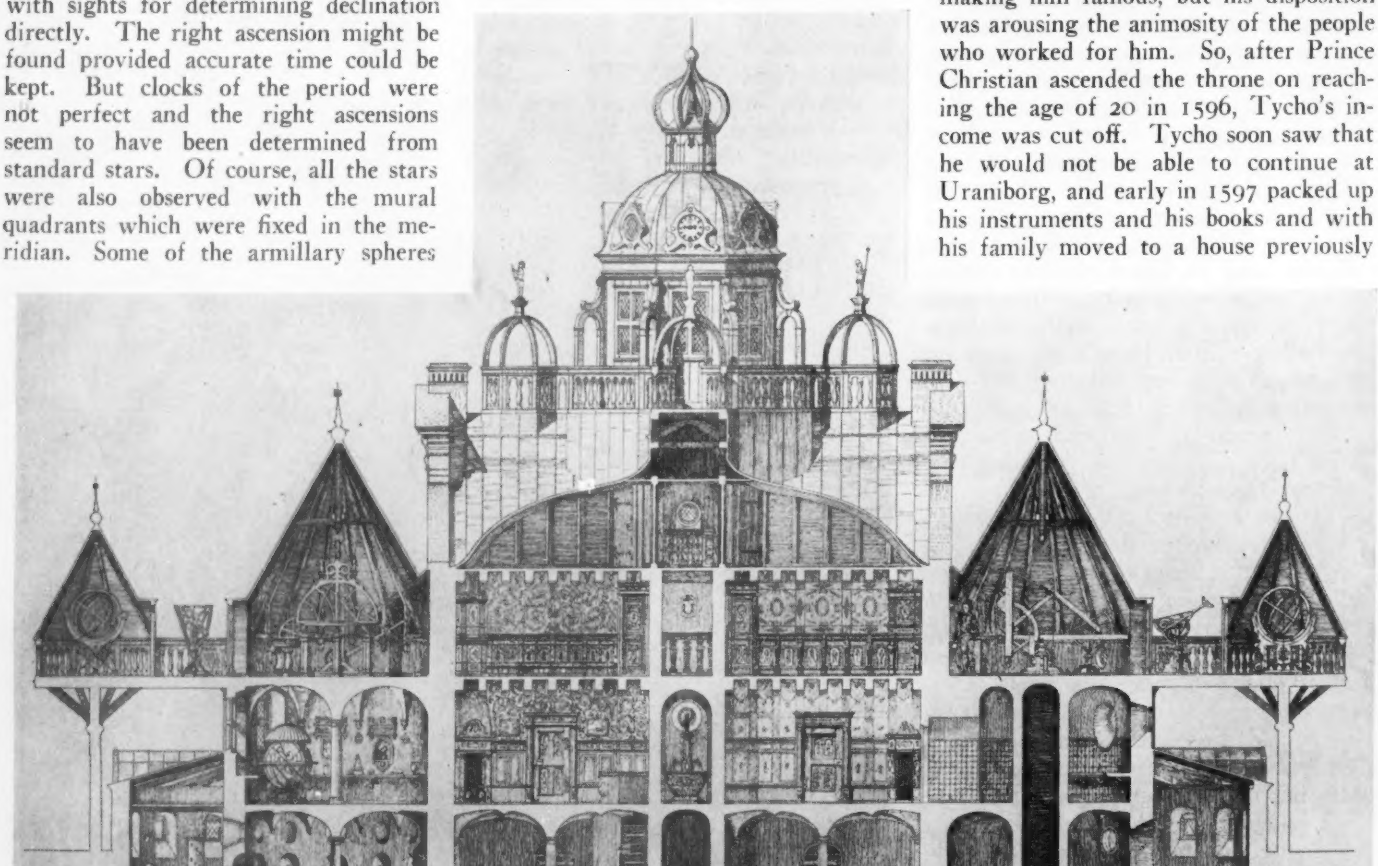
The study was furnished simply with a long table and some clocks. Here was kept an eight-foot semicircle of brass, which was taken outside and placed on a stand when it was to be used. On the ceiling was a representation of Tycho's "system of the world" and on the walls were portraits of eight astronomers, including Tycho himself and Tychonides, a hoped-for astronomer descendant of Tycho—a hope which never materialized.

Tycho's system of the structure of the universe does not need much explanation, since it is well known. The earth is stationary in the center with the moon and sun revolving in circles around it—the system thus retaining some of the Ptolemaic principles. But the planets revolve around the sun, instead of around the earth. Tycho knew about the heliocentric system of Copernicus, but because he could not detect any parallax for the stars he assumed that the earth was fixed and did not move around the sun as center.

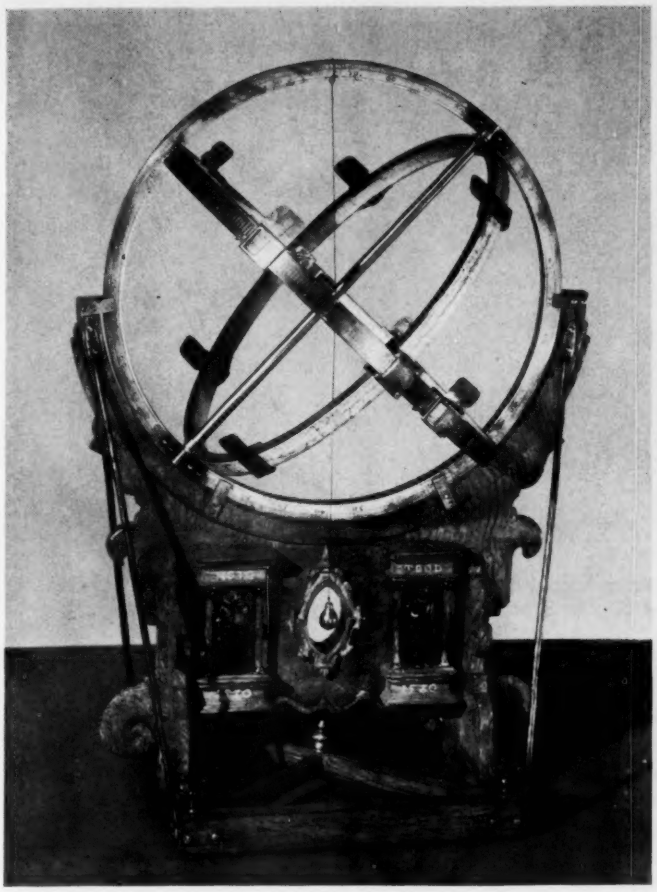
During the two decades of observing at Uraniborg, observed star positions were plotted on the great globe, which was finished after about 25 years of work. Their positions were published, 777 in his book ***Astronomiae instauratae Progymnasmatum,*** and also in a catalogue of 1,000 stars.

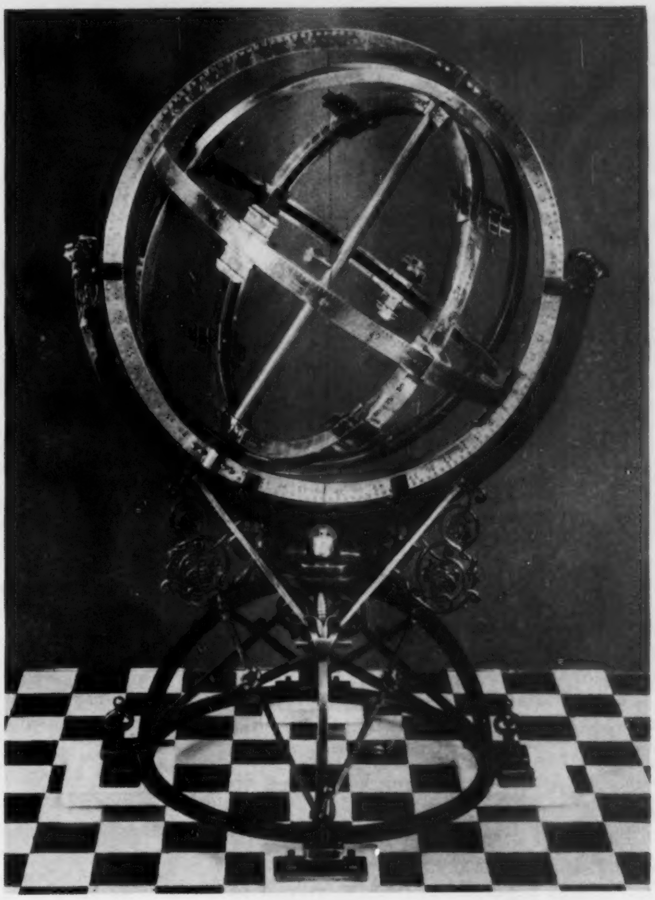
In spite of Tycho's difficult and overbearing personality, which led to problems with the peasants and workmen on Hveen, the protection of the king continued until his death in 1588, 12 years after the founding of Uraniborg. In return for the feudal income of the island and other grants from Frederick, Tycho rendered certain services. He cast horoscopes and made predictions about the lives of the royal children, and apparently furnished the king with an almanac each year. It is quite evident in these astrological predictions that Tycho's heart was not in his work and that, especially in his later years, he had lost almost all his belief in astrology, serving the king only because he was commanded to do so, and refusing to grant other requests for predictions of events to come.

After the king's death in 1588, Tycho continued to enjoy the patronage of the new government. But life was becoming more difficult. His work was making him famous, but his disposition was arousing the animosity of the people who worked for him. So, after Prince Christian ascended the throne on reaching the age of 20 in 1596, Tycho's income was cut off. Tycho soon saw that he would not be able to continue at Uraniborg, and early in 1597 packed up his instruments and his books and with his family moved to a house previously



In the excellent book "Uraniborg og Stjaerneborg," by Beckett and Christensen (1921), appears this reconstructed cross section of the main Uraniborg building.





Among the models of Brahe instruments made by L. C. Eichner are these two armillary spheres. The left one was in Tycho's northern observing room; the right one was in the southern observing room. American Museum photographs.

prepared in Copenhagen. They stayed there only a few months. Then Tycho left Denmark forever, taking with him all his instruments, his printing press, and his chemical apparatus, and accompanied by about 20 persons — his family and a few students and servants.

From summer, 1597, to spring, 1599, the Brahe family moved from one place to another in Germany, until Tycho finally went to Prague to enter the service of Rudolph the Second, the emperor of Germany, who was more interested in science and the arts than he was in government. The emperor gave Tycho the use of a large estate some 20 miles from Prague, where the construction of an observatory was begun, to house the instruments which had been brought from Hveen. Finally all 28 instruments were assembled. But because of difficulties in collecting the money appropriated by the emperor to run the establishment, Tycho left the estate and moved to Prague, and the instruments were moved again to a villa belonging to the emperor.

During these difficult years, Tycho was in correspondence with a young mathematician named Johannes Kepler. Kepler finally was received by the master as an assistant. Among other hopes, Kepler had expected to be given Tycho's observations of the planets. But Tycho guarded this long series of observations with considerable jealousy, and only gave Kepler a minor part in the planetary theories he was working on. Thus, Kepler became dissatisfied and left the observatory.

Kepler was very poor, even dependent on the small salary he was supposed to receive from Tycho. After some difficulty about the salary, Kepler again went to live at Tycho's house. He was also well received by the emperor and was given the post of Imperial mathematician, on condition that he help Tycho in the preparation of the new planetary tables, a fortunate circumstance, because in that way Kepler obtained possession of the data which he had long hoped for, which led the way to the discovery of his famous laws.

By the middle of 1601 Tycho was in such bad health that although he was only 54 years old, Kepler remarked, "the feebleness of old age was upon him." About the middle of October, while a guest at a dinner, he was taken ill. After about two weeks of suffering, the end came on October 24, 1601.

Tycho is almost certainly best known for his planetary observations, which were used after his death for the theories of planetary motion worked out by Kepler. But his observations of the sun and moon, continued over a lifetime of observing, gave more accurate data regarding the sun's motion than had been known before, and led to the discovery of new inequalities in the motion of the moon. It is strange that Tycho still used Copernicus' parallax of the sun instead of using a parallax determined from his own observations. He had already corrected the tables of refraction and correctly interpreted refraction as being caused by the earth's atmosphere.

We have already mentioned his tables of the positions of 1,000 stars, and the fact that he made his own instruments with accuracy unsurpassed before the invention of the telescope. His observations of comets proved that they are more distant than the moon, and settled forever the arguments that comets are part of the earth's atmosphere. He had observed the aurorae and thought them to be "sulphurous exhalations ignited in the air, and not clouds illuminated by the sun, as the latter was too far below the horizon in winter."

Tycho's observations stand ahead of those by Hipparchus for accuracy. His theory of the structure of the universe ranks with that of Ptolemy, but was inferior to the Copernican system. It is unfortunate that he did not live another 10 years to share Galileo's knowledge of astronomy as improved by telescopic observations. But the brilliance of Tycho's methods of observing without optical assistance places him equal to the most famous astronomers of all time.

The group of scientists gathered to celebrate the diamond jubilee of Cordoba Observatory. Dr. Gaviola, director of the observatory, is fourth from the right in the front row.

The Cordoba Anniversary

By W. J. Luyten, *University of Minnesota*

THE SUDDEN INFLUX of observatories from the north into the Southern Hemisphere during the past few decades has made us almost forget that there are many justly famous observatories there which have rendered yeoman service to astronomy for years and are, in fact, much older than many of our northern institutions. Such a one is the Cordoba Observatory, which celebrated the 75th anniversary of its founding in September of 1946.

Dr. Roscoe Sanford, of Mount Wilson Observatory, and the writer were the two astronomers from North America who had the good fortune to be invited to participate in the ceremonies as guests of the Argentine government. This report of some of the events at Cordoba in September is necessarily brief.

Cordoba was founded in 1871, with B. A. Gould as its first director. He immediately began epoch-making work in mapping the southern skies, and his successor, Juan Thome, carried on the project. Both these men came to Argentina from North America. Cordoba publications are too familiar and too indispensable to all astronomers to need to be recalled in detail here.

The third director was C. D. Perrine, who migrated from Lick Observatory, and it was a genuine pleasure indeed to see him again at the meeting and to hear him read a paper on the errors and regulation of clocks and watches.

When the change in the character of astronomy came, Cordoba changed too, and did its share in the southern zones of the Astronomische Gesellschaft catalogues and of the astrographic catalogues, being one of the few southern observatories nearly to complete both these assignments. When astrophysics developed, Perrine planned for a 60-inch reflector, which as director he did not see completed; nor was it finished under his successor. But the telescope was finally put into operation in 1942 under the present director, Enrique Gaviola, who described the instrument in *Sky and Telescope,* March, 1942.

This Schmidt camera is operated at the Cordoba station of the observatory.

And a fine instrument it is. It is located some 50 kilometers southwest of the city of Cordoba, at Bosque Alegre, which means "pleasant woods," although now there are no woods there and, when the cold south wind howls, it is far from pleasant according to the observers. In ease of handling, ingenuity of devices and gadgets that make the observer's life pleasant, it has few equals, and the new spectrograph with a grating and a camera of the Schmidt type is an optical gem, designed by Dr. Gaviola. His optical genius and the able collaboration of Dr. Ricardo Platzeck are apparent in the entire layout of the observatory and shops, in old and new instruments including a new Schmidt telescope, exceedingly light and easy to handle.

Beyond these things, it was evident from the meetings that Dr. Gaviola is the spark plug behind most of the physical science in Argentina, the organizer of the Argentine Physical Association, and the one who is slowly but effectively convincing the government that science should occupy an important place in modern life. His appreciation of the international aspect of astronomy has been especially demonstrated to the writer, who has had the good fortune to participate in a co-operative observing program with the Cordoba Observatory for nearly six years now, and this alone has made it possible to complete the white dwarf survey of the southern hemisphere of the sky. Several interesting new white dwarfs have been announced by Martin Dartayet, of Cordoba, and the writer, found on plates taken with the astrographic telescope at Cordoba or the 60-inch at Bosque Alegre.

In addition to all this, the astrophysics division of the observatory is represented by Dr. Guido Beck and Dr. Platzeck, and minor planets and comets are observed and their orbits computed by Dr. Jorge Bobone.

After commemorative exercises on the evening of September 19th, at which Dr. Gaviola summarized theories of stellar and planetary evolution, stellar constitution, and the source of stellar energy, the scientific sessions began the next morning. This constituted the eighth meeting of the Argentine Physical Association. Most astronomical papers were dealt with that day. These included a detailed discussion of the spectrum of T Coronae Borealis by Dr. Sanford; progress reports by the directors of the Montevideo and Santiago observatories; a demonstration of the new Cordoba Schmidt; a paper by Dr. Jorge Sahade on eclipsing variables; a paper by Dr. Bobone on the definitive orbit of Halley's comet on its latest return; a paper by Dr. H. Wilkens, of La Plata Observatory, on galactic absorption.

To me one of the most interesting papers was by Landi Dessy, of La Plata, on the binary star p Eridani — the famous anomaly with components too massive for their luminosities, and too faint

(Continued on page 25)

Amateur Astronomers

THIS MONTH'S MEETINGS

Boston: The speaker at the meeting of the Bond Astronomical Club at Harvard Observatory on Thursday, January 2nd, at 8:15 p.m., will be Father Michael Ahern, S.J., Weston College.

Chicago: On Tuesday, January 14th, the Burnham Astronomical Society will meet at 8:00 p.m. at the Chicago Academy of Sciences Auditorium. There will be a short talk on "Watchers of the Sky in 1947," by J. M. Showalter. The main portion of the program will be on the subject, "Making My Own Telescope," to which five individuals will contribute.

Cleveland: "Astronomy in Europe During the War" will be discussed by Dr. G. B. van Albada, of the Warner and Swasey Observatory, at the January 10th meeting of the Cleveland Astronomical Society, 8 o'clock.

Detroit: The Detroit Astronomical Society will hold its annual business meeting with election of officers on January 12th, Sunday, at 3:00 p.m., Wayne University. Astronomical films will be shown by members, as well as slides of Cranbrook and the McMath-Hulbert Observatory. There will be informal dinner at the close of the meeting.

Geneva: A regular meeting of the Fox Valley Astronomical Society will be held on January 21st at 8 o'clock in the Geneva City Hall. A symposium, "Hobnobbing with the Third Planet," will be led by Professor Clarence Smith, of Aurora College. "Jupiter and its Satellites" will be discussed by the Rev. Frank Hancock.

Indianapolis: "Out into Space" is the subject of the talk by Paul Richey at the meeting of the Indiana Astronomical Society on January 5th, 2:15 p.m. at Odeon Hall.

Madison: The Madison Astronomical Society will meet at Washburn Observatory on January 9th at 8 o'clock. Two members will give talks — "First-magnitude Stars," by Dr. J. H. Gieselman, and "White Dwarfs," by Frank Clark.

New York: Dr. Clyde Fisher, honorary curator of the Hayden Planetarium, will speak on "Our Mysterious Moon," before the Amateur Astronomers Association on January 8th. The meeting is at 8:00 p.m. in the lecture hall of the Roosevelt Memorial, American Museum of Natural History.

The Junior Astronomy Club, meeting on January 24th at 8:00 p.m. at the Roosevelt Memorial, will hear Dr. Peter van de Kamp, of Sproul Observatory, lecture on "The Milky Way."

Philadelphia: Dr. Louis C. Green, of Haverford College, will address the Rittenhouse Astronomical Society on "The Light of the Sun," on Friday, January 10th, at 8:00 p.m., in the Morgan Physical Library of the University of Pennsylvania.

Pittsburgh: John E. Roblee, of the Westinghouse Electric Corporation, will speak on "Atomic Power" at the meeting of the Amateur Astronomers Association on January 10th, at the Buhl Planetarium at 8 o'clock. This talk was scheduled for last September, but was cancelled at that time because of the Pittsburgh power strike.

Washington, D. C.: Dr. B. W. Sitterly, of the Nautical Almanac Office of the U. S. Naval Observatory, will speak at the monthly meeting of the National Capital Astronomers on Saturday, January 6th, in the Commerce Department Auditorium. His subject will be "The Demon Stars."

CENTRAL HIGH SCHOOL DEDICATES PLANETARIUM

Continuing the interest which Philadelphia's Central High School has shown in astronomy during the past century, the first public school planetarium in the United States was formally dedicated on December 11th, as a memorial to the late Franklin Spencer Edmonds, one of the school's illustrious alumni.

Several hundred guests attended the dedication exercises, which were followed by an inspection of the planetarium equipment. A. C. Schock, head of the mathematics department, past president of the Rittenhouse Astronomical Society, and formerly a lecturer in the Fels Planetarium, demonstrated the star projector and other equipment. He is now head of the Edmonds Planetarium.

The planetarium equipment was supplied by the Peerless Planetarium Company, Ltd., of Toronto. It includes a star projector which shows all stars down to the 4th magnitude, the Milky Way, and conspicuous nebulae and clusters. Planet projectors can be set for any desired date; the moon projector includes a device to show the phases; and the sun projector includes an eclipse mechanism.

In addition to producing daily motion of the celestial sphere, the projector can be rotated on a horizontal axis to show the appearance and motion of the skies as seen from any place from pole to pole. Auxiliary projectors show meridian and equator, and hour and declination circles. Other equipment includes demonstration devices to explain seasonal changes, eclipses, transits, retrograde motion, and the phases of the moon.

The dome at the Edmonds Planetarium seats between 50 and 60 people.

Planetarium Notes

ADLER PLANETARIUM

900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m.

STAFF: *Director,* Wagner Schlesinger. *Other lecturer:* Harry S. Everett.

January: THE STARS OF WINTER. The ancient figures are shown as the principal constellations and stars are pointed out; and many of their myths and legends are presented.

February: EXPLORING THE UNIVERSE.

BUHL PLANETARIUM

Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300

SCHEDULE: Mondays through Saturdays, 3 and 8:30 p.m.; Sundays and holidays, 3, 4, and 8:30 p.m.

STAFF: *Director,* Arthur L. Draper. *Other lecturers:* Nicholas E. Wagman, J. Frederick Kunze.

January: UNDER WINTER STARS. Simple methods are shown for locating the winter constellations and, with the ancient star pictures appearing in the heavens, visitors hear some of the sky legends of long ago.

FELS PLANETARIUM

20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Rittenhouse 3050

SCHEDULE: **3 and 8:30 p.m. daily; also 4 p.m. on Saturdays, Sundays, and holidays. 11 a.m. Saturdays, Children's Hour (adults admitted).**

STAFF: *Director,* Roy K. Marshall. *Other lecturers:* I. M. Levitt, William L. Fisher, Armand N. Spitz, Robert W. Neathery.

January: LEARNING THE STARS. The bright winter stars afford a good opportunity to begin to learn the sky. The traditional figures will be projected on the sky, grouping the stars into constellations.

February: TO THE SOUTH POLE.

GRIFFITH PLANETARIUM

P. O. Box 9866, Los Feliz Station, Los Angeles 27, Cal., Olympia 1191

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m. Extra show on Sunday at 4:15 p.m.

STAFF: *Director,* Dinsmore Alter. *Other lecturers:* C. H. Cleminshaw, George W. Bunton.

January: A PREVIEW OF THE 1947 SKY. An outline of the interesting events which will be seen in the sky in 1947 is presented this month.

February: A JOURNEY THRU TIME.

HAYDEN PLANETARIUM

81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.

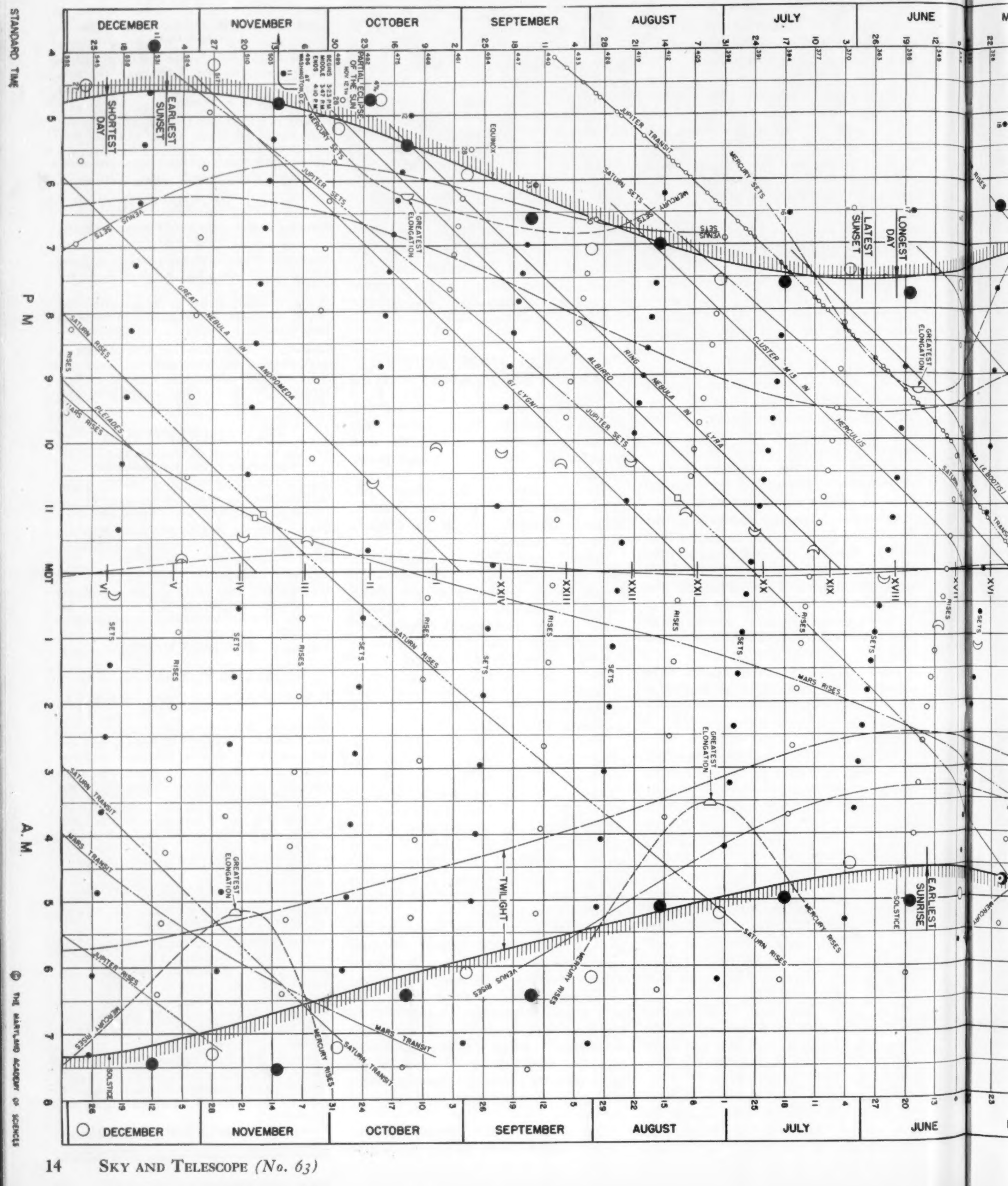
STAFF: *Honorary Curator,* Clyde Fisher. *Chairman and Curator,* Gordon A. Atwater. *Other lecturers:* Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Edward H. Preston.

January: WINTER CONSTELLATIONS. In this lecture we explore some of the most strikingly beautiful constellations and learn the secrets of such stars as Betelgeuse, Sirius, and Aldebaran.

February: OUTPOSTS OF THE HEAVENS.

Graphic Time Table of

PREPARED BY THE MARYLA[ND] AC[ADEMY]



f the Heavens - - 1947

A ACADEMY OF SCIENCES

The Graphic Time Table of the Heavens

while still available may be secured without charge directly from the Maryland Academy of Sciences, Pratt Library Building, 400 Cathedral St., Baltimore 1, Md. Blueprints of the original drawing before reproduction are available at cost — 75c each — 40x27 inches. An edition in French for latitude 47° north may also be obtained.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight and the ending of evening twilight; the times when certain stars and other objects of interest transit (cross the celestial meridian); phases of the moon; the equation of time; and other astronomical information. To illustrate by an example: The events of the night of January 2-3 may be found by following the horizontal line for that date across the graph from left to right. The Julian Day number for that evening is 2,432,188. The sun sets at 4:46 p.m. standard time; evening twilight ends at 6:23 p.m.; Saturn rises at 6:42; the Pleiades cross the meridian at 8:56; the Great Nebula in Orion transits at 10:47. The equation of time curve shows that the sun is slow and will not be on the meridian until four minutes after 12 o'clock noon, local time, January 3rd. Saturn transits at 1:50 a.m.; the moon is three days past first quarter and sets at 3:14 a.m.; Jupiter rises at 3:23; and so on.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon. Circles on the Jupiter transit curve indicate nights on which occultations or eclipses of Jupiter's bright moons occur between 7:00 and 11:00 p.m. EST. Small squares on planet curves indicate quadrature, and oppositions are marked by the conventional symbol of two joined circles.

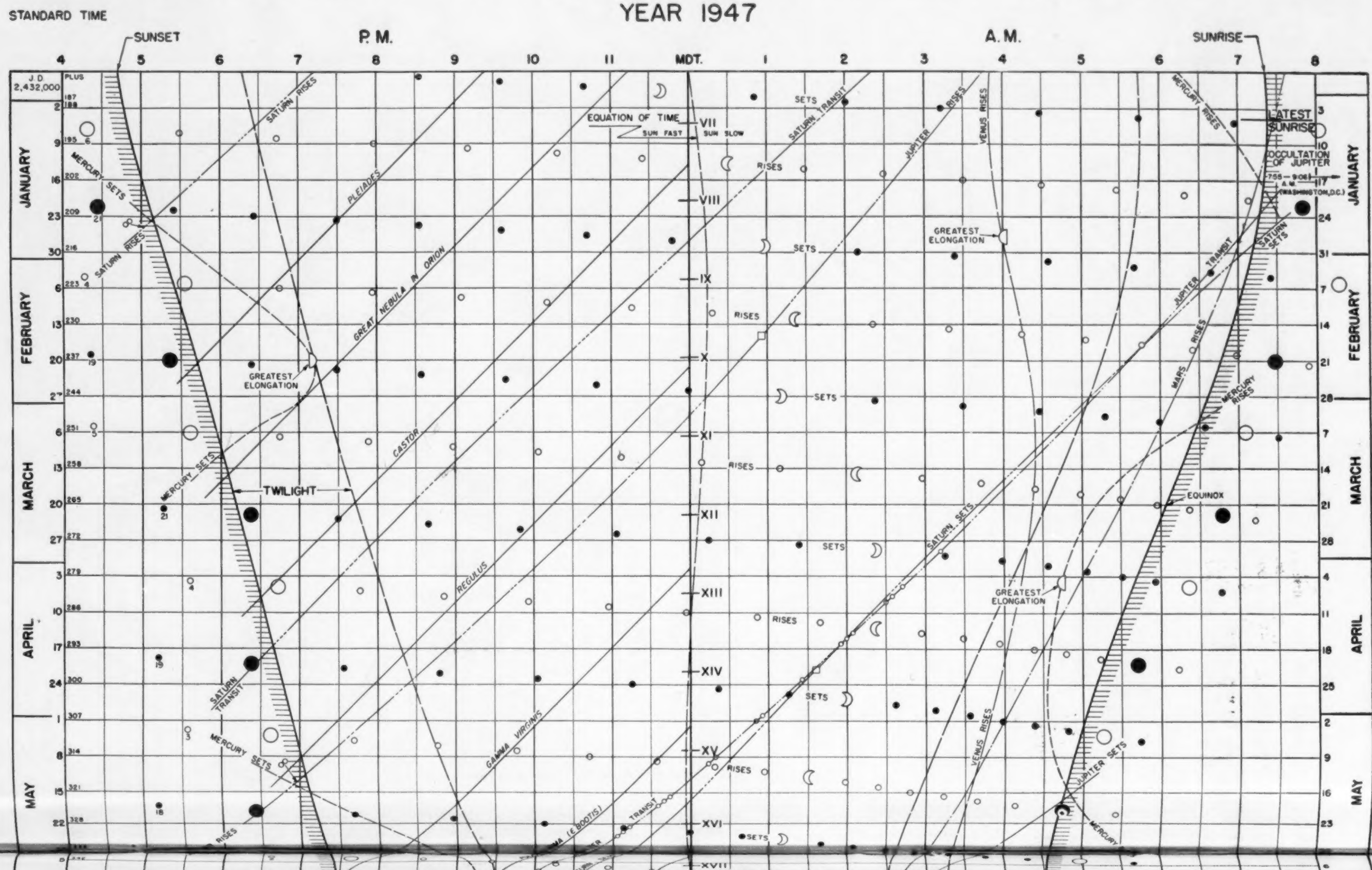
How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets, are absolutely correct for only one point on the earth's surface — for this chart: latitude 40° N. and longitude 90° W. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded.

Correction for difference in longitude depends principally on the observer's distance east or west of his standard time meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

Atlanta	+38	Denver	0	New Orleans	0
Baltimore	+ 6	Detroit	+32	New York	— 4
Boston	—16	Houston	+22	Pittsburgh	+20
Chicago	—10	Indianapolis	—16	San Francisco	+10
Cincinnati	+38	Los Angeles	— 7	St. Louis	+ 1
Cleveland	+27	Minneapolis	+13	Washington	+ 8

All places with plus correction are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given for lunar eclipses and Jupiter's satellites, and in the Far West slight corrections may be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."



BOOKS AND THE SKY

URANOMETRIA

Johannes Bayer. Diminished edition by Josef Klepesta, Praha, 1938. 8 pages and 36 figures. $1.50.*

JOHANNES BAYER published in Augsburg, 343 years ago, his well-known atlas of the above name, which on 41 large sheets contained charts and outlines of all northern (and some southern) constellations as tradition knew them in antiquity and the Middle Ages. During the three centuries that have elapsed since the publication of Bayer's work, ancient mythology lost much of its usefulness but none of its lure; and as far as artistic beauty and splendor of drawings are concerned, Bayer's presentation has probably remained unsurpassed. Few libraries and still fewer individuals can, however, boast possession of this now excessively rare book. We may therefore welcome the initiative of Josef Klepesta, a publisher and one of the leading amateur astronomers of Czechoslovakia, who has made most of Bayer's drawings accessible to the general public.

As to the scope and reproduction technique of this popular edition, we cannot do better than to describe it in terms of a few sentences translated from its introduction. "I selected," writes Klepesta, "36 most significant constellations from Bayer's original edition and had them reproduced photographically. The contours, on bromo-silver enlargements, of all figures and designations were then drawn over with India ink by a skillful draftsman. The enlargements were subjected to a chemical treatment aiming to remove all traces of deterioration and impurities of the 335-year-old originals, so that only India-ink drawings remained. The names of the constellations and of the individual stars were then inserted in modern [in Latin] type and the brightest stars were connected by alignment lines — a deliberate departure from the original where such lines were completely lacking. The charts so processed were eventually photographed and printed."

Quite apart from aesthetic considerations, Bayer's atlas contained many a point which contemporary astronomers may find of interest. Thus, on Table VI of Klepesta's edition we find a striking image of Nova Cassiopeiae 1572, which Bayer depicted as the immensely bright object it undoubtedly was in November of that year. Bayer knew, of course, nothing about the other galactic supernova, Kepler's Nova Ophiuchi 1604, which was to flare up a few months after the publication of his **Uranometria.**

Mira Ceti was recorded as a star of 3rd magnitude — it is questionable whether Bayer was aware of its variability discovered by Fabricius a few years before. P Cygni appeared likewise in those years as a 3rd-magnitude star and was so recorded; for according to Kepler and other observers, its brightness did not begin to fade until around 1619. It may also be of interest that Bayer is generally credited as the first celestial cartographer who started denoting the bright stars of each constellation by Greek letters in alphabetical order — a convention which has survived up to the present.

Klepesta's diminished edition of Bayer's **Uranometria** appeared in Czechoslovakia in 1938 but a copy did not reach this country till after the war. It was not intended to provide a facsimile of Bayer's entire work; but it reproduces strikingly well and on a good prewar paper the most important features. The brief text is in Czech, but the drawings and Latin names are universally understandable. The book is to be warmly recommended to all for whom the ancient celestial pictograph has not lost its lure.

ZDENEK KOPAL
Harvard College Observatory

*Sky and Telescope will transmit orders for this book, for delivery in not less than four weeks under normal mail conditions. Make check or money order payable to Sky Publishing Corporation.

DAVID RITTENHOUSE

J. Edward Ford. University of Pennsylvania Press, Philadelphia, 1946. 226 pages. $2.50.

THIS TENTH AND LATEST of the Pennsylvania Lives series adds another interesting chapter to those already published — the life of one of the most brilliant pre-Revolutionary scientists and patriots, David Rittenhouse. The carefully compiled material gives a most interesting insight into the religious and social conditions of the colonies.

With the customary education of today, Rittenhouse would be one of the world's leading minds. It is most revealing of the character of his genius that with only very little formal education he was to master the elements of Newton's **Principia** and to be its ablest champion in the colonies, a man whose talents were admired by Franklin and whose astronomical computations gained him world recognition. It is unfortunate that his physical weakness, gastric ulcers, was not then understood by medicine, for his sufferings greatly handicapped his social and scientific life.

However, had it not been for Rittenhouse's weak constitution, his father might have more strongly urged him to become a farmer. As it was, at the age of 17, Rittenhouse, with his father's help and permission, built himself a workshop and started his famous line of clocks and scientific instruments. Perhaps the most famous of his instruments is the orrery, admired today by all instrument makers for its mechanical and mathematical accuracy.

Although we have no position in this country comparable with England's Astronomer Royal, several times Rittenhouse was proposed, by petition in the Assembly, to be appointed to an office of public astronomer for the province. War clouds gathered faster than the lawmakers could decide on the issue, and it never became a fact.

Throughout his life Rittenhouse's interests were amazingly broad. He was at various times a clockmaker, provincial surveyor, astronomer, and mathematician. He showed active interest in meteorology, optics, magnetism, and the principles involved in steamboats. Among other offices, he served as state treasurer, director of the first U. S. mint, and as an instructor at the College of Philadelphia. This book, the first full biography of David Rittenhouse in a hundred years, pays tribute to one of America's outstanding citizens, and records a fascinating and inspiring life story.

ROBERT E. COX

NEW BOOKS RECEIVED

THE SOOCHOW ASTRONOMICAL CHART, *W. Carl Rufus* and *Hsing-Chih Tien*, 1945, *Univ. of Michigan Press.* Two plates & 24 pages. $2.50.

A discussion of a star chart made in 1193 A.D. as part of material prepared for the instruction of a future emperor of China.

STARCRAFT, *William H. Barton, Jr.*, and *Joseph Maron Joseph*, Second Revised Edition, 1946, *Whittlesey House.* 250 pages. $2.75.

Another edition of this book designed for persons of all ages interested in astronomy, telescope making, constellation study, and special activities.

In Focus

THIS MONTH'S BACK COVER picture is the first in the series of nine which will portray the last-quarter moon. Compare this with Plate IV, which appeared in May, 1946. There is considerable overlap along the terminator, but it is of interest to note how the features change in appearance when the illumination is from the other side.

Below are short descriptions of some of the formations of particular interest, either physically or biographically. All named features in this part of the moon are indicated on the key chart, but all are not described. Spellings follow the International Astronomical Union's **Named Lunar Formations,** by Blagg and Mueller, and biographical information is from the British Astronomical Association publication, **Who's Who in the Moon.**

Ball. A crater about 25 miles across, with a central mountain. William Ball was a 17th-century amateur astronomer, who made careful observations of Saturn, and was one of the founders of the Royal Society.

Birt. A crater on Mare Nubium. A cleft runs outside its eastern wall.

Blancanus. Giuseppe Biancani was the author of **Sphaera Mundi,** and a teacher of Riccioli. On the moon, this is a walled plain near the southern limb, with its floor about 12,000 feet below the surrounding mountains. Do not confuse this with Blanchinus, which also appears on this month's map, or Bianchini, a small ringed formation near Sinus Iridum.

Clavius. The largest walled plain on the moon, whose diameter is given by Goodacre as 150 miles. Many craters are inside the main formation.

Heinsius. A walled formation with an interior crater, and two large craters right in its southeastern wall.

Hell. Twenty miles across, with high walls, and quite conspicuous, named for Maximilian Hell, director of Vienna Observatory in the late 18th century. He observed the 1769 transit of Venus in Lapland, and studied terrestrial magnetism there the preceding winter.

Hesiodus. This ringed formation is just to the east of Pitatus, and has in its floor a small and distinct crater. A long valley runs eastward from Hesiodus. The name is after the early Greek poet, Hesiod.

Lexell. A ringed plain with much detail. Goodacre points out that its walls are much reduced by erosion, particularly on the north side. Named for the discoverer of Lexell's comet. Lexell was in England at the time Herschel discovered Uranus, and was the first to prove that the object was a planet beyond Saturn, and not a comet.

Longomontanus. A self-educated Danish peasant, who took a Latin name, became Tycho's assistant at Hveen and Prague, and later returned to Copenhagen as a professor of mathematics. On the moon this is a walled plain nearly 100 miles in diameter, with a central peak, and a large group of craters inside its northeast wall.

Mare Nubium. Part of the Sea of Clouds appears on this month's cover.

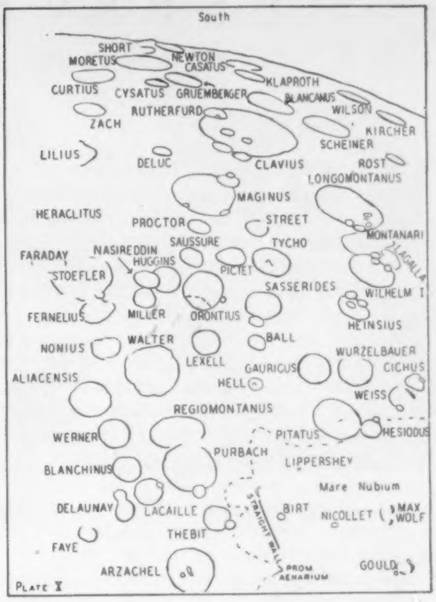


PLATE X

Nasireddin. Named for the Persian astronomer, Nasir-al-Din (1201-1274), who received patronage from the grandson of Genghis Khan. At his specially built observatory, he and his assistants wrote on astronomy and geometry and translated Greek works, developed trigonometry, and determined the value of precession as 51 seconds of arc.

Nicollet. A crater a little over 10 miles across, on Mare Nubium. Nicollet worked at the Paris Observatory, chiefly in lunar study. **Who's Who in the Moon** gives his name as possible author of the famous moon hoax story about 100 years ago, also credited to Richard Adams Locke.

Orontius. A large ringed plain, with interesting detail in and around it. A French mathematician of the 16th century, Orontius Finaeus was a professor in the college which developed into the Collège de France. He designed an orrery, and wrote on optics, cosmography, astrolabes, and methods of determining longitude from lunar observations.

Pitatus. A large ringed plain with a smooth floor, a low mountain in its center, and a pass through its walls into Hesiodus.

Regiomontanus. A large walled plain, irregularly shaped, named for a 15th-century astronomer and mathematician, pupil of Purbach and teacher of Walter, between whose namesakes he is situated on the moon. Regiomontanus was founder of the first modern observatory in Europe, at Nuremberg. Observations made by him and carried on by his pupil were of great aid to Tycho.

Sasserides. Gellio Sasceride spent six years at Uraniborg as a pupil and assistant. He later became a professor of medicine at Copenhagen. On the moon, he and Longomontanus, another pupil of the famous master, are near Tycho.

Straight Wall. This unique formation is a fault, about 60 miles long, and with walls about 500 feet high. On the waxing moon, it is seen by its shadow.

Tycho. This famous crater is over 50 miles across, and has a central mountain. Its walls are about 12,000 feet high. The rays which radiate so conspicuously from Tycho at full moon are barely visible and only to the east under this illumination.

OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

An Occultation of Jupiter

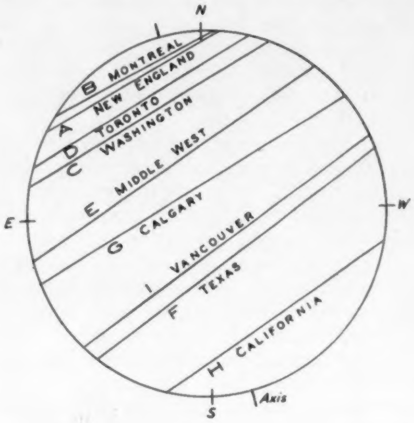
EARLY RISERS will be rewarded on the morning of January 16th, a Thursday, by an occultation of Jupiter which is scheduled to be seen all over the United States and lower Canada. From the predicted data for the eight standard stations, we have plotted on a disk representing the moon the position angles of immersion and emersion for each station (that for Vancouver immersion is estimated). The apparent path of Jupiter behind the moon is shown, as is also the position angle (13°) of the moon's axis.

It will be daylight along the Atlantic Coast when immersion takes place, but a telescope should easily enable one to observe Jupiter pass behind the moon and reappear about an hour later. For observers in the northeast, emersion will occur not far from the terminator, which will have a position angle of about 15°; for station **B**, only 18° of the moon's limb will separate Jupiter and the terminator.

Farther west, where the whole occultation will occur in darkness, Jupiter's satellites add considerable interest to the show. By a peculiar coincidence, the time of immersion at stations **G** and **H** (Calgary and California), 11:57, is the same as that given in the **American Ephemeris** for the reappearance of Satellite II from occultation by the planet, its eclipse having begun at 7:13.3 GCT that morning. Therefore, an observer exactly at station **H** could watch to see whether or not the satellite became visible just before the moon covered it. All observers along the West Coast may find it interesting to look for this telescopic phenomenon.

Those without telescopes can enjoy the occultation also, and it is suggested that attempts be made to see Jupiter by daylight after its reappearance, the moon serving as a guide to the planet. Here is also an opportunity for amateurs with telescopic cameras to try to photograph the moon, Jupiter, and its satellites — a very difficult task!

Long-focus cameras are desirable, or attach a camera or film-holder to the eyepiece of your telescope. The exposure should be short because of the moon's brightness (at immersion), but long because of the relative faintness of Jupiter's satellites—a compromise is indicated. The belts of Jupiter will show under high magnification.

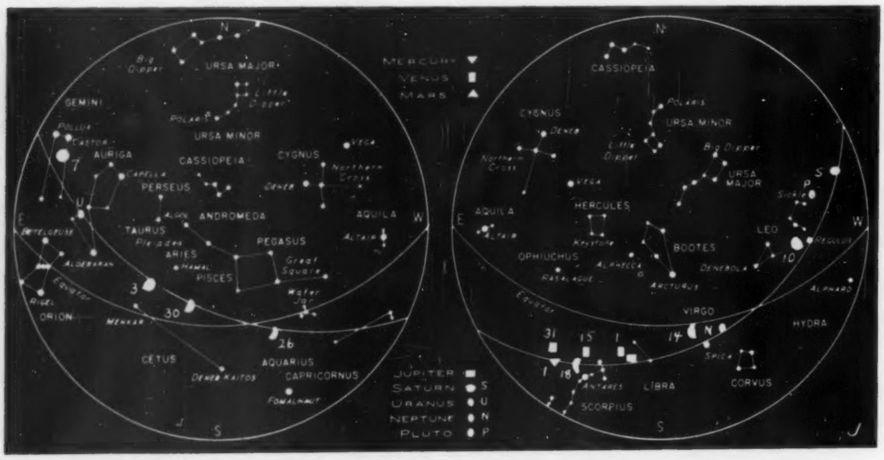


Film should be panchromatic, fine-grain, fast if no clock drive is available. Exposures are a matter of experience, and depend on focal length, film speed, and the like. If focus is very long (100 inches or more), take pictures directly in the focal plane; otherwise projection through an eyepiece will enlarge the planet sufficiently.

An ideal series would show the gradual immersion of the planet at the moon's bright limb, and might include one or two satellites. At emersion, however, with the bright limb out of the way, a clock-driven camera ought to aim at a series showing the satellites and Jupiter popping out one by one. To take the pictures at the right moments, a second visual telescope and observer would be needed, as the predicted times are subject to variation depending on distance from the standard stations.

There is no point in amateurs timing planetary occultations, so those who regularly time occultations may take this opportunity just to enjoy the spectacle.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 7:30 a.m. local time on the 7th of the month, and at 6:30 a.m. on the 23rd. At the left is the sky for 5:30 p.m. on the 7th and 4:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury cannot easily be seen, except perhaps shortly before sunrise the first few days of the month.

Venus, brilliant object in the morning sky, rises three hours before the sun. At magnitude −4.3 on the 1st, decreasing to −4.0 at elongation on the 28th, it can easily be followed with the unaided eye into the daytime sky.

Earth reaches perihelion on the 4th.

Mars is too near the sun for observation; it is in conjunction with the sun on the 6th.

Jupiter is in central Libra, slowly moving eastward. It is at magnitude −1.4. An occultation on the 16th will be widely observed across the United States — see the occultations column for more details.

Saturn is at opposition on January 26th, rising about sunset and setting near sunrise. Its magnitude is just zero. In a telescope the southern edge of the rings is visible at an angle of 19°.

Uranus can be found in Taurus with opera glasses. Early in the month it will be 1° north of 108 Tauri, which can be found with the aid of a star atlas. The magnitude is +5.9, slightly brighter than the star. Uranus is retrograding, but moves only a degree during the month.

Neptune is close to Gamma Virginis. On the 15th its position is $12^h\ 42^m.1$, −2° 53′ (1947).

E. O.

CORRECTION

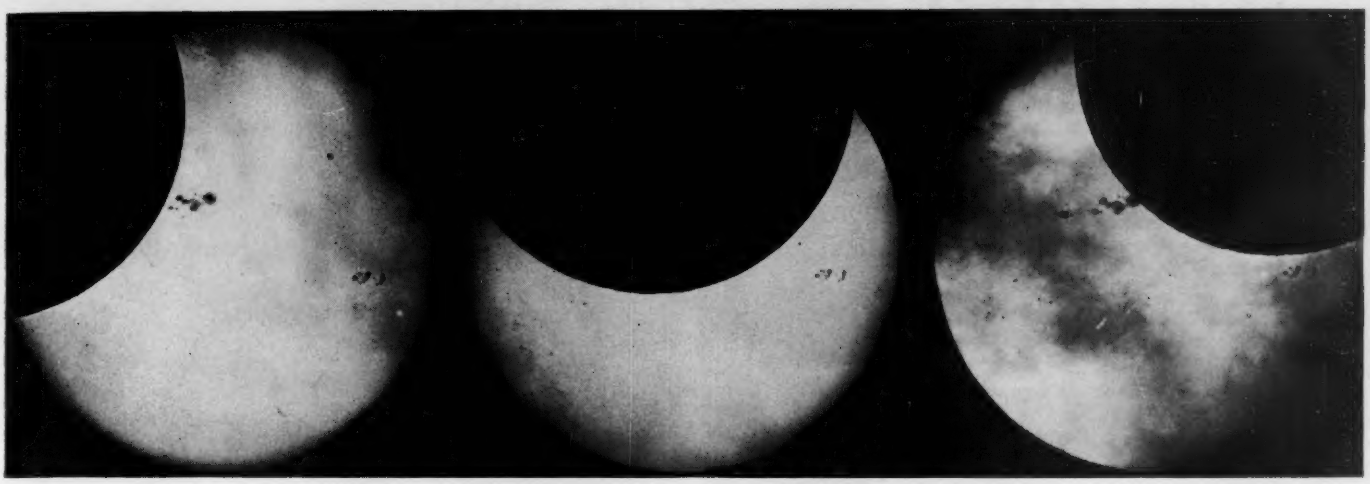
In the December issue it was stated that 1946 was the first year in 29 in which Saturn did not reach opposition. We are grateful to several readers for calling attention to the fact that on January 12, 1946, Saturn was at opposition. The statement applies to 1945, for the preceding opposition was on December 28, 1944.

PHASES OF THE MOON

Full moon	January 7,	4:47
Last quarter	January 14,	2:56
New moon	January 22,	8:34
First quarter	January 30,	0:07
Full moon	February 5,	15:50

MINIMA OF ALGOL

January 2, 12:32; 5, 9:21; 8, 6:10; 11, 2:59; 13, 23:48; 16, 20:38; 19, 17:27; 22, 14:16; 25, 11:06; 28, 7:55; 31, 4:44. February 3, 1:33; 5, 22:23.



The Kearons pictures, taken (right to left) at 11:50 a.m., 12:30 p.m., and 1:24 p.m. EST, through light clouds.

News of the Eclipse in November

FAIR WEATHER favored observers of the partial eclipse of the sun on November 23rd, and a number of more-or-less detailed reports have been received. All observers enjoyed particularly watching the moon cover and reveal a large group of spots in the sun's northern hemisphere. The Reverend W. M. Kearons, of West Bridgewater, Mass., kindly furnished a series of eight photographs, three of which appear here. Gordon Newkirk submitted photos taken at Cambridge, Mass. Excerpts from some of the reports follow:

"Thirteen members of the Astronomical Society of Maine assembled at the Harris Observatory in South Portland to observe the partial eclipse. On the sun a total of 33 distinct spots was counted, including those in the large cluster. Mountains on the moon showed as permanent irregularities along its dark edge. Several members noted faculae and granulations, the latter chiefly at intervals during 20 minutes beginning at 12:24 p.m. EST. Estimated maximum of the eclipse was at 12:27, and the last contact was at 2:03 p.m.

"It was estimated that in the triangle of spots near the equator of the sun, each of the three spots was about the size of the earth." HERBERT M. HARRIS
South Portland, Me.

"The large group of sunspots could be detected without telescopic aid; near the end of the eclipse some cloud cover permitted naked-eye observation of the solar disk without the use of protective filters. Members of the Astronomy Section of the Rochester Academy of Sciences gathered at my home, where a variety of telescopes, binoculars, and cameras were used. Paul W. Davis employed a 5-inch Clark refractor of 75 inches focal length and a 35-power eyepiece. The secondary image was focused on the film plane of a Kodak box camera from which the lens had been removed. In its place was inserted a high-speed shutter. Exposure time was 1/100 second with a red filter. No attempt was made to time the contacts to better than

OCCULTATIONS FOR JANUARY

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, limiting parallels of latitude, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	E +91°.0, +40°.0
B +73°.6, +45°.6	F +98°.0, +30°.0
C +77°.1, +38°.9	G +114°.0, +50°.9
D +79°.4, +43°.7	H +120°.0, +36°.0
I +123°.1, +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

December 31-January 1 **33 Ceti** 6.2, 1:07.8 +2-09.8, 9, +67° −19° Im: **A** 2:04.1 −1.2 −0.3 67°; **B** 2:02.8 −1.1 +0.1 56°; **C** 1:58.8 −1.5 −0.3 73°; **D** 1:55.8 −1.2 +0.3 55°; **E** 1:37.9 −1.4 +0.9 49°; **F** 1:15.6 −2.1 +1.0 63°; **H** 1:01.9 0.0 +3.3 3°.

4-5 **URANUS** 5.9, 5:11.2 +23-03.7, 13, +82° +6° Im: **F** 10:56.0 +1.0 −3.0 147°. Em: **F** 11:22.8 −0.7 +1.3 210°.

9-10 **46 Leonis** 5.7, 10:29.4 +14-24.6, 18, +83° −4° Em: **A** 10:53.6 −0.7 −2.0 311°; **B** 10:46.9 −0.7 −2.0 315°; **C** 10:55.9 −1.1 −1.7 297°; **D** 10:45.5 −1.0 −1.7 303°; **E** 10:33.9 −1.9 −0.8 276°; **G** 9:49.2 −1.5 +0.3 276°; **I** 9:34.0 −1.6 +1.2 263°.

15-16 **JUPITER** −1.4, ... , 24, +72° −5° Im: **A** 13:11.0 −3.2 +0.7 62°; **B** 13:10.2 ... ... 56°; **C** 12:55.0 −3.0 +0.4 79°; **D** 12:50.5 −2.9 +0.7 73°; **E** 12:20.5 −2.0 +0.3 103°; **F** 12:12.5 −1.1 −1.1 140°; **G** 11:57.6 −0.7 +0.9 110°; **H** 11:57.0 +0.2 −1.6 165°. Em: **A** 14:02.3 −0.9 −2.8 354°; **B** 13:53.1 ... ... 357°; **C** 14:06.0 −1.3 −2.3 338°; **D** 13:53.1 −1.0 −2.2 344°; **E** 13:44.5 −1.5 −1.3 321°; **F** 13:39.7 −2.5 −0.4 289°; **G** 13:11.0 −0.9 +0.2 308°; **H** 12:51.5 −2.1 +1.8 259°; **I** 13:01.9 −0.9 +0.7 293°.

29-30 **31 Arietis** 5.7, 2:33.7 +12-13.1, 8, +53° −27° Im: **A** 2:08.1 −1.0 +0.5 44°; **B** 2:09.4 −0.9 +1.0 32°; **C** 2:01.3 −1.3 +0.3 55°; **D** 2:01.7 −1.1 +1.0 37°; **E** 1:43.5 −1.3 +1.3 40°; **F** 1:20.4 −2.1 +0.9 62°; **H** 1:07.2 +0.2 +4.1 0°.

February 1-2 **121 Tauri** 5.3, 5:32.2 +24-00.4, 11, +77° +5° Im: **A** 3:35.0 −1.3 −2.9 131°; **B** 3:26.4 −1.4 −2.0 118°; **C** 3:46.0 ... ... 160°; **D** 3:21.4 −1.7 −2.6 127°; **E** 3:11.0 ... ... 146°; **G** 2:20.8 −1.1 +1.2 79°; **H** 2:01.7 −2.0 −0.2 116°; **I** 2:09.5 −0.9 +1.5 73°.

2-3 **Epsilon Geminorum** 3.2, 6:40.7 +25-11.1, 12, +70° +7° Im: **A** 4:42.3 −1.3 −1.5 111°; **B** 4:36.8 −1.3 −1.2 101°; **C** 4:42.8 −1.3 −2.8 128°; **D** 4:30.8 −1.5 −1.4 111°; **E** 4:18.1 −1.8 −2.2 131°; **G** 3:35.3 −1.2 +1.0 83°; **H** 3:22.4 −2.2 −1.1 130°; **I** 3:23.6 −1.0 +1.3 81°. Em: **A** 5:50.1 −1.2 −0.8 261°; **B** 5:46.0 −1.1 −1.1 269°; **C** 5:45.1 −1.7 +0.1 244°; **D** 5:40.3 −1.4 −0.5 258°; **E** 5:19.0 −2.1 +1.2 234°; **G** 4:46.4 −1.4 +0.3 270°; **H** 4:14.3 −1.2 +3.4 217°; **I** 4:33.0 −1.4 +0.7 269°.

3-4 **Kappa Geminorum** 3.7, 7:41.2 +24-31.6, 13, +68° 0° Im: **A** 1:30.9 −1.6 −0.2 115°; **B** 1:29.7 −1.4 +0.4 104°; **C** 1:24.7 −1.7 −0.6 126°; **D** 1:20.8 −1.3 +0.4 108°; **E** 1:05.0 −1.1 +0.5 109°; **F** 0:57.5 −1.5 −1.0 138°; **G** 1:10.6 +0.1 +2.2 55°; **H** 0:46.9 0.0 +1.1 86°; **I** 1:09.7 +0.4 +2.2 47°. Em: **A** 2:41.0 −1.8 +1.1 254°; **C** 2:27.6 −1.7 +2.0 240°; **E** 2:09.6 −1.2 +1.6 252°; **F** 1:40.3 −0.3 +3.2 219°; **H** 1:42.6 −0.3 +1.1 269°.

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

the nearest minute — the eclipse lasted from 10:46 a.m. to 1:48 p.m. EST.

"The partial eclipse afforded opportunity to notice and study many details often overlooked in the excitement of a total eclipse. Because the maximum phase occurred with the sun near the meridian, the moon's motion demonstrated very clearly its rapid change in declination. The counterclockwise motion of the dark notch around the disk was partially compensated by the clockwise rotation of sun and moon together along the diurnal circle. This created an illusion, during the middle of the eclipse, that the phenomenon would last much longer than predicted. Furthermore, the rapidity with which the arc of the notch waxed and waned near first and last contact created an incentive to try to observe the times of the contacts to greater accuracy at future partial eclipses."

PAUL W. STEVENS
Rochester, New York

Rochester amateurs observing the partial eclipse.

"A radio commentator said that the eclipse would not be visible in the southeastern states, but the enclosed drawings by me show that it was very noticeable here. The sunspot was very interesting."

ELIZABETH LICHTY
Daytona Beach, Fla.

"At noon, the moon appeared absolutely black. An hour later, when the multiple leader of the large sunspot group began to emerge from behind the moon, comparison of the umbra of this spot with the black body of the moon established no perceptible difference in value, with no tinge of color in either the moon or the spot. It may be doubted, therefore, whether mere contrast of umbra with photosphere can account for certain colors observed in sunspots by various workers from time to time.

"While the emergence of the leading umbra was under observation a totally unexpected appearance was seen. Last contact with the umbra had been made but the umbra seemed to hang for an instant on the limb of the moon, suddenly appearing drawn out in a tear shape with the neck of the tear touching the moon's limb. Then it was as suddenly seen to be clear of the limb, and the spot had resumed its normal shape. This appears to be a phenomenon of irradiation similar to the 'black drop' effect occasionally observed in transits of Venus."

JAMES C. BARTLETT, JR.
Baltimore, Md.

"I timed first and last contacts and occultations and reappearances of sunspots. I also photographed the solar image projected through my Newtonian reflector. The moon took 24 minutes to cover the large group of spots, and 20 minutes to uncover it completely. The entire eclipse here lasted three hours and eight minutes."

WILLIAM G. TIFFT
Seymour, Conn.

METEORS

The Quadrantids reach maximum between January 1st and 3rd, and several days before and after this some shower meteors should be observed. The only drawback to extensive observation of this shower is the wintertime cold. The moon will be at waxing gibbous phase in Aries, far from the radiant in Bootes, halfway between Eta Ursae Majoris and the head of Draco. The radiant is circumpolar at 40° north, but most meteors will be seen after midnight. Quadrantids are usually of medium speed and brightness, and rates up to 25 per hour may be expected. E. O.

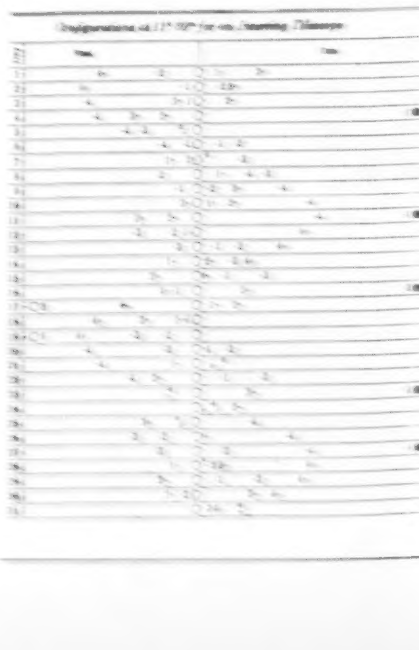
COMET BESTER

With a large perihelion distance (nearly 2½ astronomical units), this comet will remain practically of the 11th magnitude, even though it passes perihelion early in February. It does not give promise of being an important object for amateur observation, but the following predictions of positions by the Naval Observatory indicate how it may be expected to move in January, for which period an ephemeris is not available as we go to press.

Dec. 2, 3:07.9, −33° 58′; 10, 2:41.3, −30° 32′; 18, 2:19.1, −26° 42′; 26, 2:01.4, −22° 42′; 30, 1:54.2, −20° 42′.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the **American Ephemeris and Nautical Almanac.**



the nearest minute — the eclipse lasted from 10:46 a.m. to 1:48 p.m. EST.

"The partial eclipse afforded opportunity to notice and study many details often overlooked in the excitement of a total eclipse. Because the maximum phase occurred with the sun near the meridian, the moon's motion demonstrated very clearly its rapid change in declination. The counterclockwise motion of the dark notch around the disk was partially compensated by the clockwise rotation of sun and moon together along the diurnal circle. This created an illusion, during the middle of the eclipse, that the phenomenon would last much longer than predicted. Furthermore, the rapidity with which the arc of the notch waxed and waned near first and last contact created an incentive to try to observe the times of the contacts to greater accuracy at future partial eclipses."

PAUL W. STEVENS
Rochester, New York

Rochester amateurs observing the partial eclipse.

"A radio commentator said that the eclipse would not be visible in the southeastern states, but the enclosed drawings by me show that it was very noticeable here. The sunspot was very interesting."

ELIZABETH LICHTY
Daytona Beach, Fla.

"At noon, the moon appeared absolutely black. An hour later, when the multiple leader of the large sunspot group began to emerge from behind the moon, comparison of the umbra of this spot with the black body of the moon established no perceptible difference in value, with no tinge of color in either the moon or the spot. It may be doubted, therefore, whether mere contrast of umbra with photosphere can account for certain colors observed in sunspots by various workers from time to time.

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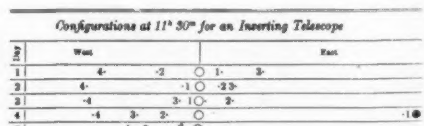

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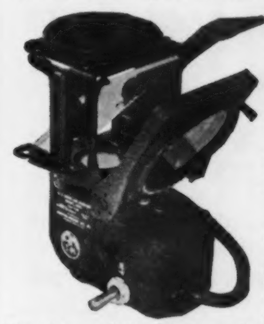

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GLEANINGS FOR A. T. M.s

The Springfield Telescope Mounting

INQUIRIES ARE RECEIVED frequently from our readers concerning the Springfield type of telescope mounting, which indicates that there are perhaps others who would like to know more of this somewhat unusual form of telescope. The Springfield mounting was developed by Russell W. Porter, and named by him after the town in Vermont where modern amateur telescope making began, and where the TM fraternity gathers each year in August at Stellafane. The first of these mountings was built there in 1920, and since that time the design has been received enthusiastically by many amateurs.

Like all types of mounting, the Springfield has its advantages and disadvantages. The case for its adoption must depend upon the consideration of all these by the individual concerned. We shall attempt here to exhibit these characteristics of the Springfield mounting, as well as state the general principles of the design, for the benefit of those who wish to compare this type with the customary German equatorial, the yoke, fork, cross-axis, or other form of mounting.

Those who decide that a Springfield is what they want to build are referred to the comprehensive articles by Porter and Ferson in **Amateur Telescope Making Advanced,** pages 333-360, 365-375. We could not expect to give a more thorough discussion of the details of design and construction, and the Porter drawings in **ATMA** are, of course, without peer.

General Principles: The basic idea of the Springfield is to provide a fixed eyepiece position, so that the observer need not move every time a new object is observed. The eyepiece is in a convenient position for all objects, which is a much larger advantage than the mere statement of it would indicate. It is not uncommon for the eyepiece of a reflecting or refracting telescope conventionally mounted to be in such an inaccessible position that the physical discomfort in-

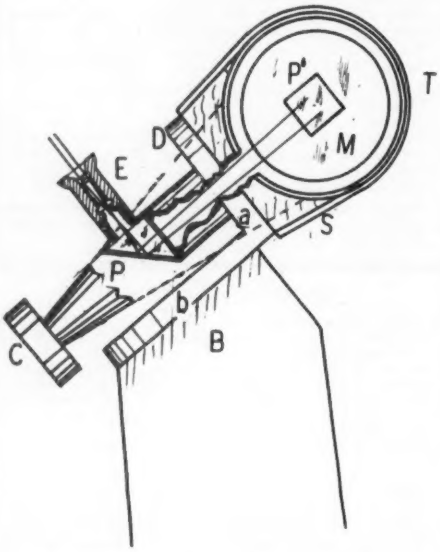

Fig. 1. The Springfield mounting, side view, showing the optical system. T, tube; M, primary mirror; P, P', prisms; S, saddle; D, declination axis; C, counterweight; E, eyepiece; B, base; a, declination circle; b, R. A. circle.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comments, contributions, and questions from its readers.

EDITED BY EARLE B. BROWN

volved is sufficient to overcome all the pleasure of the view, let alone the accuracy of the observation.

The only point in a telescope mounting which is fixed in position is the intersection of the two axes, the polar axis and the declination axis. If we place an eyepiece in this position, and make it parallel to the polar axis, it will not change its position as the telescope moves. The light must be brought to this eyepiece along the declination axis, which necessitates two prisms, one immediately beneath the eyepiece, and the other inside the tube at the intersection of the mirror axis and the declination axis. Of course, diagonal front-surface mirrors may be used instead of prisms.

Thus, the Springfield applies to the small telescope the same principles of construction used on larger professionally made instruments to bring the image into a sealed, constant-temperature room, usually at the south end of the polar axis. In order to accomplish this change, a few variations from the conventional equatorial are necessary, and certain features not needed in the German type become essential in the Springfield.

In the first place, the declination axis

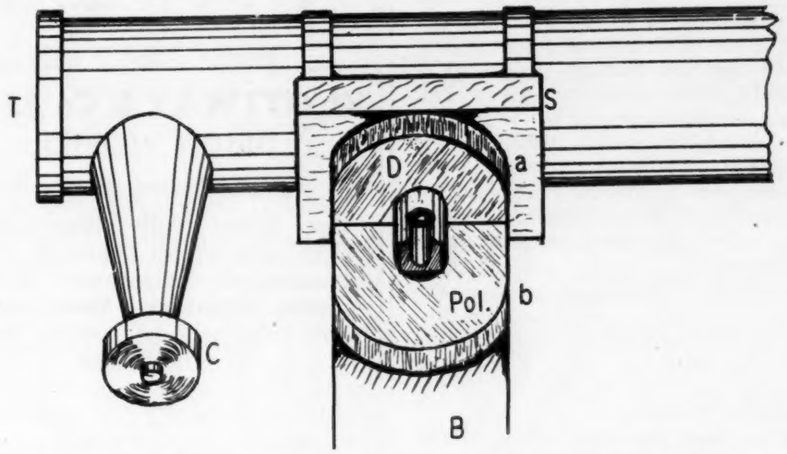

Fig. 2. The Springfield mount, front view. T, open end of the tube; S, saddle; C, counterweight; Pol, polar axis; D, declination axis; B, base.

must occur at the upper end of the tube (Newtonian), which leads to a counterweighting problem. The usual type of counterweight is shown in Fig. 2; it must, of course, be heavier than in the German mounting.

The observer, sitting in one position, loses, one might say, all sense of direction so far as the telescope tube is concerned, hence setting circles are almost a must, and these in turn practically necessitate a permanent mounting. A finder is unnecessary, but a clock drive is obviously desirable.

The accompanying drawings, Figs. 1 and 2, show the essential features of the Springfield mounting and its principal parts. These diagrams are schematic only, no attempt being made to show mechanical details such as shafts, bearings, and braces. Such parts are subject to infinite variation, and are thoroughly covered in the **ATMA** references already given. Fig. 1 shows the optical system of the Springfield. Setting circles and slow motions are added at **a** and **b**.

Advantages: 1. We have already discussed the fixed eyepiece position, an advantage which it would be difficult to overestimate.

2. With the fixed eyepiece position, the eyepiece is sturdily mounted and not subject to the vibration which almost always takes place when the eyepiece is at the front end of a long tube fastened to the mounting at its center.

3. When equipped with setting circles and slow motions, the Springfield gives the observer all controls and indicators within a few inches of the eyepiece, in convenient positions for manipulation.

4. The eyepiece position makes the taking of observation notes and the preparation of sketches and charts as simple as for the user of a microscope.

5. The Springfield mounting is well adapted to the Cassegrainian telescope. It is not suitable, however, for a refractor.

6. It is a relatively simple matter to build a house for the observer and to leave the telescope outside, thus providing comfort without temperature difficulties.

Disadvantages: 1. The principal disadvantage of the Springfield mounting is that to build it requires a lot of work, involving several special castings and a large amount of machine work. For the man of limited means and limited shop facilities the Springfield is a poor choice.

2. It is hardly advisable, though not impossible, to build the Springfield as a portable instrument. This leaves the city dweller pretty well out of the picture.

3. The size and position of the counterweight make it, to say the least, a menace to life and limb. Many a Springfield owner has had his head come into painful contact with the counterweight. Some have accordingly put the counterweight at the end of a long curving arm above the open end of the tube. This gets it out of the observer's way, but into the way of others who may be about.

4. If the Springfield is without setting circles, the difficulty of locating objects is annoying to one first using this type of mounting, but a little practice will overcome this problem.

5. The field of view rotates in a seemingly unpredictable fashion as the tele-

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 40 cents a line per insertion. six words to the line. Minimum ad is three lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

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FOR SALE: 10" mirror, aluminized. Focal length 79"—regular figure. Will accept best cash offer, or exchange for long focal length ocular, or on refractor objective of three to five inch aperture. Claude E. Hall, 940 Seymour, Napa, Calif.

FOR SALE: 10x80 German submarine binoculars automatic color filters. 3¼" objectives. Tripod needed. Ideal for yacht or mountain country or stars. $250.00. Frank W. Manning, 4321 Perrier St., New Orleans, La.

DESIRE contact with manufacturer interested in development and marketing of what I call an "astronomical viewer." Item estimated to be salable in camera and optical shops. Educational features would stimulate telescope sales. Write Box 87, Linden, Mo.

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FOR SALE: German Busch 10x80 tank binoculars, filters, 45° eyepieces, very good condition, very rich field and ideal for comet hunting. Weight 15 lbs. $150.00. Russell Campbell, 2010 No. Zarzamora, San Antonio 1, Tex.

FOR SALE: 8" plate glass silvered mirror, 130" focal length. Has good spherical figure. Will sell to highest bidder above $50.00. Write to Don M. Wrathall, Grantsville, Utah.

scope is moved over the sky. But this cannot be considered a serious objection, as the same phenomenon takes place in the conventional reflector when the observer changes his position, which is often.

6. It is necessary to add another prism to the optical system. The disadvantage from an optical standpoint is insignificant, especially since the additional prism is not obstructing the incoming light (as is the first one) but the alignment problems occasioned by the addition of one more reflection are not to be overlooked.

E. B. B.

THE CORDOBA ANNIVERSARY

(Continued from page 12)

for their spectral classes. The explanation is probably very simple: both components of the binary appear to be spectroscopic binaries on plates taken at Cordoba's Bosque Alegre station.

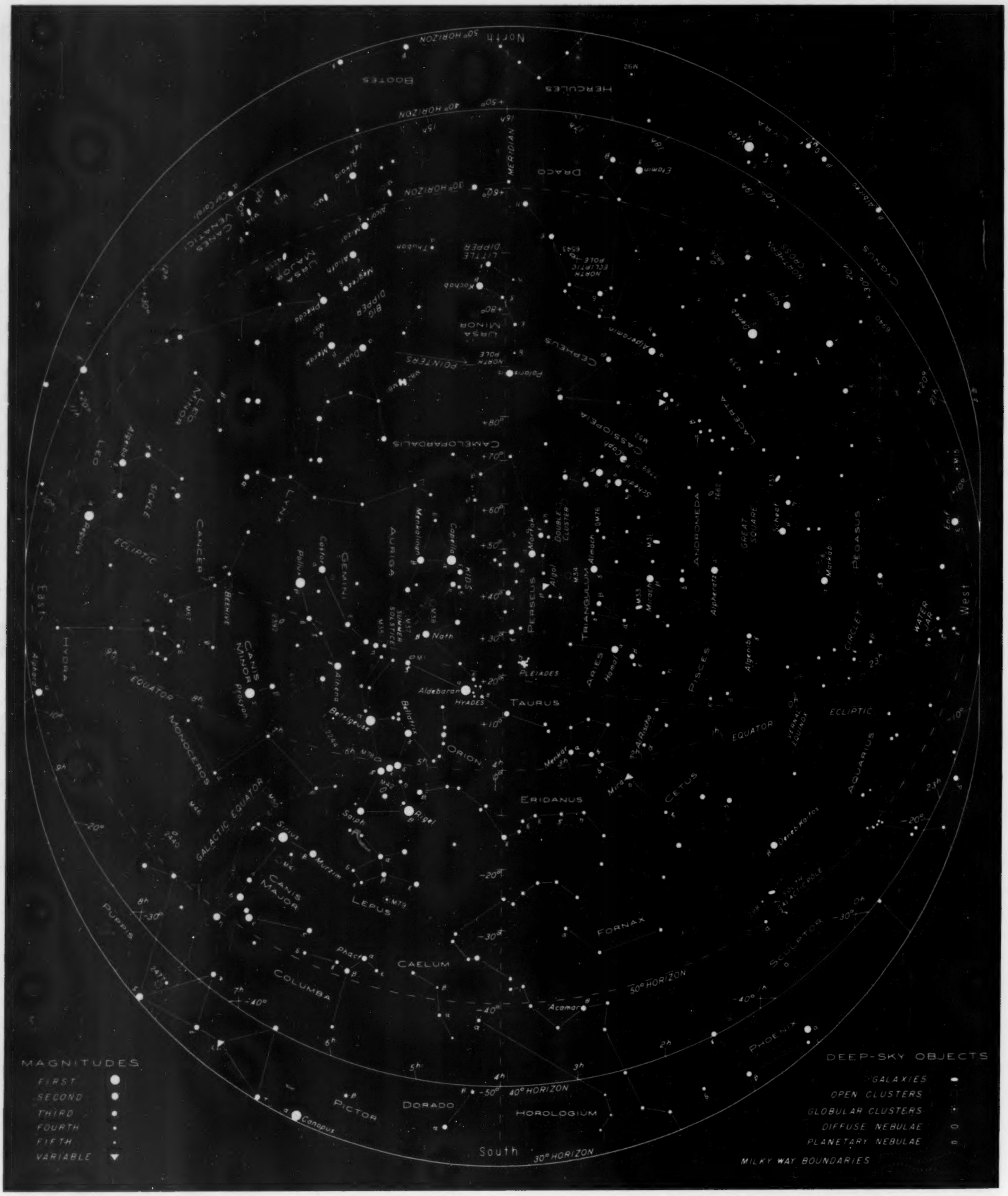
The present writer announced six new white dwarf components of binaries, found during a survey of such stars undertaken jointly with Dr. P. D. Jose at the Steward Observatory.

While the author was probably the only person present who did not speak or understand Spanish, this proved to be not too much of a handicap for the astronomical papers. When, however, on Saturday the big guns of theoretical physics were turned loose, the difficulty became serious, and I often lost the thread of the argument. One thing was very evident even so — the vigorous discussions convinced me not only of the deep interest in the subject, but their content gave me a profound respect for the very high level of the study of physics in South America.

No report of these meetings could be complete without mention of the continuous solicitude for our comfort and the equally continuous and varied social occasions, including the *asados* at Bosque Alegre and at the observatory. These are a sort of barbecue where we made acquaintance with excellent and plentiful Argentine meat and with other dishes. Fiestas were attended and very much enjoyed, including those in which we were introduced into the honorable society of criollos — drinkers of mate tea.

And, to one from North America unacquainted with the beauty of the south, the trip was something fantastic — the crossing of the endless estuary of the Amazon, the descent into the indescribably beautiful bay of Rio, and the crossing of the majestic Andes between Mendoza and Santiago, with 22,835-foot Aconcagua on the right — these are but a few highlights of an unforgettable experience.

We noted during our visit how well South America seems to stir its melting pot of nationalities, perhaps better than the United States does now. We came away with renewed faith in the unity and friendship of the Americas and in the internationalism of science.



DEEP-SKY WONDERS

THE TAURUS-AURIGA region contains one of the greatest collections of galactic clusters known. M38, NGC 1912, 5^h 22^m, +35° 45′, is magnificent in any sized instrument. Cuffey places it at 860 parsecs. Seven parsecs distant from it is NGC 1907, 5^h 21^m, +35° 14′, smaller, but apparently forming a binary system with 1912, period 7×10^7 years.

NGC 1893, 5^h 19^m, +33° 18′; small, delta-shaped, imbedded in nebulosity, traces of which can be seen in amateur telescopes.

M36, NGC 1960, 5^h 30^m, +34° 04′; is bright and compact, 12′ in diameter. About 130 parsecs in space from the M38-NGC 1907 system, it is too distant from them to be part of a stable physical system.

These areas contain many of Barnard's dark nebulae, of which B34 at 5^h 36^m, +32° 40′, can be faintly glimpsed on dark nights with rich-field telescopes.

WALTER SCOTT HOUSTON

STARS FOR JANUARY

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

Chart correction: Beta and Gamma Lyrae should be reversed.